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General Economic Stimulation and Energy Indicators for Capital Investment Initiatives in Various Transportation Modes

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General Economic Stimulation and Energy Indicators for Capital Investment Initiatives in Various Transportation Modes

Authors:	B.L. Allen, D.W. Butterfield, M.L. Kliman, A.A. Kubursi, J.D. Welland, McMaster Institute for Energy Studies; A. Kazakov, Research and Development Branch
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Ministry Contact:	Alex Kazakov (416) 235-4683
Abstract:	Transport Impact Model is an interactive computer model developed to calculate the economic impact of capital investment in transportation infrastructure. The model is developed for personal computers (IBM). TRIM's base is the economic input-output model of Ontario Economy and a database of cost allocation for a set of standard transportation expenditure projects. The model is flexible enough to allow the modification of standard projects to obtain a better estimate for a specific one. The report presents the model and discusses the interpretation of the results obtained from running the model. Examples of the application of the model are also presented. The model and manuals are available from the Ministry of Transportation, Research and Development Branch.
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B.L. Allen

D.W. Butterfield

M.L. Kilman

A.A. Kubursi

J.D. Welland

McMaster Institute for Energy Studies

A. Kazakov

Highway Innovations and Strategic Research
Research and Development Branch

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For additional copies, contact:
The Editor, Technical Publications
Room 320, Central Building
1201 Wilson Avenue
Downsview, Ontario
Canada M3M 1J8

Telephone: (416) 235-3480
CNCP Dialcom Electronic Mail: 23:MIN006

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1/ Introduction

The primary purpose of capital spending by the Ministry of Transportation of Ontario (MTO) is to provide new and expanded transportation services for the people of Ontario and to aid in maintaining the quality of the services already provided. But capital expenditures also have secondary effects on Ontario's economy. They affect income, employment and production inside and outside the province, they generate tax revenue of various sorts, and they use energy resources.

Such secondary effects are of interest to both the political authorities who decide how much of the government's budget should be assigned to transportation and the Ministry staff who receive the money and allocate it over a broad range of transportation activities. These groups want to know what the impacts of each activity within each project are, how this varies with a shift in activity emphasis, and to compare economic impacts across quite different projects, even when they are in different parts of the transport sector. The report describes the development of a Transport Impact Model (TRIM), a comprehensive analytical tool that will provide the Ministry with indicators of the secondary effects of its programs.

The Transport Impact Model is a self-contained user-friendly program that runs on any IBM-compatible personal computer. With TRIM, Ministry analysts will be able to calculate impact indicators for alternative proposed capital projects in minutes. In the present version of TRIM, they may view the impacts of 35 pre-defined typical projects, either individually or in combinations; they may adjust the assumptions made about these typical projects; and they may insert their own specially defined projects into the system.

Our analytical approach is conceptually simple, but it is comprehensive, flexible and rich in detail. A given spending project is evaluated in two steps. First, a list of the goods and services that will be used in the project is prepared: the dollar values of labour, equipment and materials that go into constructing each standardized physical unit of the facility involved. (Up to 20 categories of project inputs are involved. The list is provided on the computer disk and described in Chapter 3 of this report.) This "recipe" forms the input data for TRIM. By entering it into the model one can calculate the effects of the project expenditure on a series of variables relating to the Ontario economy. These variables provide the information required for the budgetary decisions of different management groups: the variables are indicators of economic stimulation and energy use associated with Ministry projects.

Chapter 2 of this report describes the thinking behind the Transport Impact Model, sets out the variables that are calculated as indicators of the effects of Ministry capital expenditures and discusses their interpretation. Chapter 3 describes how the data that define a simulated project are constructed and entered into the model. As already mentioned, TRIM's database contains data for 35 typical transportation capital projects; these projects are described in detail in Chapter 3.

The typical user of TRIM can obtain a general understanding of the nature of the model by reading the main text of this report. The reader who wishes a more comprehensive and mathematically precise description of TRIM will find it in Appendix A. It includes references to published data sources and descriptions of special aspects of the data which determine the parameters of this particular model.

The general user's understanding of the model can be further enhanced by the discussion in Chapter 4 of several illustrative runs of the model. The output of TRIM is described for four of the typical projects defined in the model's database. Also in Chapter 4 are some illustrations of how TRIM can be used to analyse the impacts of the Ministry's expenditures in larger categories, such as total capital expenditures by modal program.

Although this initial project has been ambitious, it has not been possible within it to develop our analytical approach to its full potential. In Chapter 5 we discuss the potential further development of the model and its application.

2/ Economic Impacts: Background

This chapter is intended to familiarize the user of TRIM with the ideas underlying the economic stimulation and energy indicators calculated by the model.

2.1/ Tracing Industrial Processes

The process of production and consumption in a complex economy such as that of Ontario is based on an extensive system of relations among individual industries. Few, if any, products are manufactured by one industry operating in isolation. Rather the production process typically is dependent on a chain of intermediate processors and suppliers that provide the inputs essential for the final production of any good or service.

As a result, when the demand for a good or service rises the producer in turn increases the demand for the various materials and services that are used in the production process. Each of the supplying industries subsequently must increase their demands for materials and services, thereby transmitting the effects of the original increase in demand throughout the economy. At each stage in this process there is an accompanying increase in incomes, a portion of which is passed on in the form of wages and salaries. This results in an additional demand for consumer products, which itself adds to the demand on producers.

In a modern economy every industry is a part of a chain of this type. However, the extent and complexity of the chain varies from industry to industry and from one region to another. Some products require a multitude of inputs supplied by a variety of industries, while others can be produced more directly from raw materials with relatively little requirement for intermediate goods or imports.

Clearly, the more extensive the linkages between a particular industry and the rest of the economy, the greater the impact an increase in demand for that industry's products will have on employment and incomes. Similarly, the consequences of a reduction in demand for the product of an industry with extensive linkages are more serious than for a case in which linkages to other industries are minor. The identification of the economic impact of an activity is, therefore, an important part of the development of policy on employment, economic stability and other desirable socio-economic objectives. The identification of the economic impacts provides policy-makers with consistent information on the ranking of different activities in terms of an objective set of socio-economic indicators.

This argument obviously applies to decision-makers in a public transportation agency. Such agencies generally pursue multiple objectives, among them: the provision of transport services; the economic development of regions and urban areas; and the conservation of natural resources. Financial, institutional, environmental and other constraints often imply that any one of these goals may be realized only at the expense of foregoing others. Tradeoffs have to be made and it is essential that public decision-makers have a well defined account of the effects associated with alternative choices, measured consistently across programs.

2.2/ Input-Output Models

Input-output analysis provides a framework within which industrial linkages, and the feedbacks between consumers and the producing sector of the economy, can be simulated. The approach involves modelling the economy in a set of linear equations that can be manipulated and solved mathematically. Statistics Canada provides an extensive set of data which allows the representation of an actual economy within such an input-output framework. Data are available at the level of each province (although not in as much detail as for the national economy). Thus, the input-output model can be used with data from the Ontario input-output table to trace the linkages described above.

The present project uses an input-output system to develop a set of economic stimulation and energy indicators that show the effects of capital expenditures made by the Ministry of Transportation. That is, the indicators in this study have been defined as economic impact variables produced by the input-output system. They show the secondary effects of a given expenditure by the Ministry. (The primary effects are the actual transportation services produced as a result of Ministry spending.)

There are many types of secondary economic impacts that can be of interest to decision-makers. The following impact variables were included in the Transport Impact Model.

Ontario Impact Indicators Calculated by TRIM

Labour Income
Gross Domestic Product (at market prices)
Employment
Gross Sales
Tax Revenue (by level of government & type of tax):
- Personal Income Tax
- Indirect Business Tax
- Customs Duties
- Corporate Profits Tax
- Property & Business Tax
- Total Tax Revenue (Federal & Provincial)

Imports from other provinces
Imports from abroad
Primary Energy Consumed:
- Coal
- Crude Oil
- Natural Gas
- Electricity
- Other
- Total Primary Energy

For each of the variables shown above, an economic impact is defined as the sum total of changes, in all sectors of the economy, associated with a given project or program expenditure – here an expenditure on a capital project by the Ministry. These changes are typically broken down into initial, indirect, and induced effects and are shown that way in TRIM.

Initial Effects: The initial effect is the change in the impact variable closely associated with the original expenditure itself. For instance, in the case of Gross Sales the initial effect of a transport project expenditure is the value of equipment and materials required to construct the facility involved; or, otherwise put, it is the project expenditure itself less the payments to labour working directly on the project and the profit generated directly by the project.

In the case of Gross Domestic Product (at market prices), GDP, the initial effect is equal to the value of materials, equipment, and labour used plus profit and indirect taxes paid. It can also be seen to be equal to the original expenditure: i.e. the sum of the input values entered into TRIM in the first place. The initial Employment impact variable measures the number of person-years of work used directly in project construction. The initial Labour Income is the sum of wages and fringe benefits paid to this amount of labour.[1]

Indirect Effects: The output of one industry cannot be expanded without drawing on the output of other industries. Indirect impacts are those associated with the production of intermediate goods and services that enter into the initial inputs. Note that there are many rounds of indirect effects. For example, an initial input into highway construction is mineral aggregate. To deliver the amount required, the quarry operator uses equipment which consumes fuel. The delivery of the extra fuel is part of the indirect effect: it is part of a first round of intermediate goods expenditures which follows the initial expenditure. But to deliver the extra fuel, a petroleum wholesaler also has to use extra fuel. This is a second round indirect effect. The extra demand for fuel by the gravel supplier and the petroleum supplier together creates an extra need for fuel at the refinery, creating a third round, and so on. This process continues until the extra increments of production in subsequent rounds become negligible.

Induced Effects: As income expands due to the initial and indirect effects, households will increase their purchases of goods and services, thereby giving rise to still further changes in production and corresponding changes in all of the other impact variables. These *multiplier effects*, that work through changes in household consumption, are referred to as induced effects.

2.3/ Problems of Interpretation

Some cautionary notes are in order in regard to the interpretation of impact indicators. First, the logic of the input-output calculation assumes that unemployed resources are available to be applied to the extra production associated with an increment of expenditure. Thus, extra output and employment will accrue in real terms only if the economy is operating with excess capacity and

[1]Some contributors to the literature on input-output analysis deal with direct, indirect and induced effects, instead of initial, indirect and induced effects.. By "direct effect" they generally mean the effects of the original expenditure plus the first "round" of spending on intermediate goods brought about by it. In that framework, the "indirect effect" then refers to the second and subsequent rounds of intermediate goods spending. We have chosen to separate out the expenditures made directly on the project being analysed, referring to all other expenditures as indirect or induced, because we think it will help the user of TRIM to avoid some complex problems of interpretation. At the same time, so that those who are familiar with the input-output literature may avoid confusion, the term "direct effect" is not used at all.

unemployment. Otherwise, the consequences of extra demand for output would show themselves in higher costs and prices as the new projects displace old activities. Even in an economy with some unemployment, but not high levels of it, some of the extra demand may show up in higher costs and prices due to bottlenecks in particular industries and input markets.

Second, one must take care not to misinterpret the benefits to the people of Ontario implied by the calculated impacts. Since the impact variables measure things generally viewed as desirable — output, employment, etc. — it is common to refer to increments in them as benefits. In this respect it is important to remember that what the model is accounting for is the specific increment to production associated with a specific increment to expenditure. If that extra production happens to use inputs that would have been used elsewhere, there is an opportunity cost incurred that is not being accounted for in the model. Even if there are sufficient amounts of unemployed inputs to produce the extra product with no apparent cost in terms of reallocated resources, there may still be spillover social costs (i.e. pollution, traffic congestion, etc.) and these are not accounted for in the model. Special attention should be given to the meaning of the employment impact variable. Many new jobs in Ontario may be filled by people from outside the province; while this might have desirable consequences (overall Canadian unemployment decreases), it should be understood that it will not bring about proportional reductions in Ontario's unemployment rate. Finally, recall again that the model does not measure the value of a project to the primary user (i.e. to the road, airport or transit user); it calculates only the secondary benefits brought about by the expenditure, and not the primary ones.

In general, then, TRIM is not providing estimates of the total net benefits of a capital project expenditure. Rather, it is providing estimates of changes in a specific range of variables. While these changes are properly associated with undertaking the project, they do not tell the whole story. It is important for the user of the model to take care to interpret calculated impacts with caution. Some illustrations of how the results may be described (assuming a situation in which incremental production utilizes previously unemployed resources) are provided in Chapter 4.

It can be noted as well that the model is normally used to analyse the impact of specific projects. The impacts calculated, and the problems of interpretation referred to above, relate to this kind of use. The model does not account for the fact that the Ministry has an annual flow of expenditures on many different projects, all of them generating income and employment on a regular annual basis. In such a broader framework, which would refer to the Ministry's whole budget, a project would have a net impact only if it could be viewed as an addition to this annual base flow of expenditures. TRIM can, of course, be a useful aid in such overall budgetary analyses. It can supply comparable information on the secondary effects of the expenditure on different social

programs. In this report, however, the model is treated as a device for analysing specific projects or programs, and these projects or programs are pictured as net increments to expenditures. Adjustments to the results to account for the possibility that the addition of one project is associated with the withdrawal of another are left to the user.

2.4/ The Formal Model

A computational device that comprehensively traces the inter-industry processes discussed above and calculates the values of numerous variables associated with that process will obviously be quite complex. The typical user of TRIM need not be concerned with the formal definition of the model. It will be sufficient for the user to understand the nature of the data that must be entered into the model (dealt with in Chapter 3) and the interpretation of the results produced by the model (discussed above and again in Chapter 4). At the same time, an account of the actual calculations should be available to the user who wants to know them. Thus, a complete description of the Transport Impact Model, along with a description of the sources of data used to set the model's parameters, is provided in Appendix A.

3/ Input Data

3.1/ Introduction

This chapter is concerned with the nature of the data that describe the Ministry of Transportation's projects to be analysed with the Transport Impact Model. Recall from the discussion in Chapter 2 that the purpose of TRIM is to calculate the values of economic stimulation and energy indicators for capital projects financed by the Ministry. In this report the values of these indicators are referred to as economic impacts.

From the user's point of view, an important part of TRIM is the set of input data contained in the computer program that describes 35 typical transportation projects. For each of the transportation modes associated with the Ministry's five major programs, we have identified a number of typical projects. Each typical project is carefully described and is referred to as a standard unit project (SUP). The user can call upon any SUP from this database and instruct TRIM to calculate the impact indicators requested.

Each SUP is described in terms of a standardized set of physical input categories. Thus, in addition to running any SUP through the model, the user can adjust the values assigned to these input categories to emulate better a specific project which may differ from the SUP. Taking that possibility to its logical end, a user can construct an entirely new set of project input data to simulate the impacts of a Ministry expenditure for a facility not covered in the TRIM database.

It is, therefore, useful to describe how the data on standard unit projects were constructed. This will help the user to apply the SUP database to its full potential and to construct unique unit projects that have not been included in TRIM.

3.2/ Standard Unit Projects

The identification of standard unit projects was set in motion by a series of background discussions with members of the Ministry's Provincial Transportation programs: Airports, Provincial Highways, Municipal Roads, Provincial Transit and Municipal Transit. These discussions provided, in addition to a broad understanding of the services involved, the names of people involved in the construction and operation of particular types of transportation facilities. Meetings held with a selection of these people, and others identified independently by the research team, along with

consultation with our contact in the Research and Development Branch, led to the identification of specific well-defined projects. In some cases these meetings also led to the provision of raw data on the standard unit projects so identified.

With such data in hand, or with merely the qualitative choice of the type of project to be included in the database, members of the research team then obtained information from professional engineers involved in actual design and construction.[2] For a given standard unit project this involved first the development of a list of tasks required to construct or service the transport facility involved. For instance, in the case of a municipal arterial road, this list included: excavation of the existing road base; grading and shaping the subbase; covering with granular "A"; granular backfill for soft spot excavation; adjustment of manholes, catchbasins and valve chambers; construction of curb drains; relocation of utilities; and so on until the full recipe for the unit-section of road was well defined.

With the help of professional engineers and estimators, the cost for performing each of these tasks was obtained and that cost was broken down into the categories of inputs defined by the Ontario input-output table. Examples of these categories are wage payments, equipment fuel, non-metallic mineral products (i.e. gravel), primary metal products, electrical products, and so on. The result was a cost data matrix for each standard unit project, with the tasks defining rows and the input categories defining the columns. Tables showing these cost data for each standard unit project are gathered together in Appendix 3A, attached to this chapter. To illustrate the discussion at this point Table 3.1a reproduces the data matrix for standard unit project A6, a stretch of two-lane urban road 100 metres long.

When the TRIM program is executed on a microcomputer, the user will choose at the outset whether to calculate impact indicators for a standard unit project contained in the TRIM database or whether to construct a unique simulated project.[3] If an existing SUP is chosen, the user still has the option of viewing the table of input costs, in which case a list of cost categories like the one shown along the top of Table 3.1a will appear on the screen. (The actual list is longer because some SUPs have additional cost categories. For SUP A6, shown in Table 3.1a, the latter categories will contain zeroes.) The column total for each cost category is the number entered into the TRIM input cost list. Using these cost data, the program will calculate the economic impacts of a

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[2]The exception in this respect is the set of Provincial Highway projects, the raw data for which were obtained from the Ministry's earlier development of the Micro-Economic Impact Evaluation System. Further details on these data are provided later in this chapter in section 3.5 – Provincial Highways.

[3]This is true for the "expert " version of the program. In the "standard" version the user is given no option: only the standard-unit-projects can be run.

complete reconstruction of a 100 metre section of a typical two-lane urban road, or of any of the other SUPs chosen from the menu.

Suppose that a TRIM user is interested in the economic impacts of a project similar to the one shown in Table 3.1a, but one in which the use of certain inputs is judged to be a bigger or smaller portion of the total cost than in our SUP. The entry in the cost category list (the column total in the table) can be adjusted accordingly and the SUP can be run through the model with the new data. The question of how a particular column total should be adjusted can be dealt with more accurately (at least in the case of a user who is knowledgeable in relation to the construction of a given transport facility) by going through each task from the list on the left-hand side of the table, first verifying or adjusting the cost of that task, and then adjusting the column entry accordingly.

In a similar way, by filling in an empty matrix with positive values and zeros in appropriate places, an entirely new and different project can be defined.

Table 3.1a/ Sample Data: Standard Unit Project A6
Two-Lane Urban Road Reconstruction (Dollar Values)

	Total	Administration		Labour			Equipment			Non-Met.
		Overhead	Profit	Wages	Fringe	Fuel	Repairs	Insurance	Depreci-ation	Minerals
Task										
Earth Excavation	6020	482	120	2252	337	368	283	57	2122	0
Granular "A" (450 mm)	9450	756	189	987	147	123	95	19	709	4284
Hot-Mix HL-8 (80 mm)	7650	612	153	865	129	99	77	15	574	1595
Hot-Mix HL-3 (40 mm)	4080	326	82	461	69	53	41	8	306	765
Concrete Curb and Gutter	5250	420	105	1233	184	82	63	13	473	0
Hot-Mix HL-3 Fine in Driveways	990	79	20	241	36	21	16	3	119	106
$CaCl_2$	460	37	9	40	6	3	2	0	17	0
Adjust Existing Manholes	1335	107	27	441	66	0	0	0	0	0
Water for Compaction	250	20	5	98	15	15	11	2	84	0
Relocation of Utilities, Miscellaneous	3549	710	177	772	115	115	89	18	665	0
Engineering Design	3123	874	219	1766	264	0	0	0	0	0
Engineering Construction Management	2732	765	191	1545	231	0	0	0	0	0
Column Total	44889	5188	1297	10702	1599	879	676	135	5069	6749
	1	2	3	4	5	6	7	8	9	10

SUP A6 (continued)	Non-Met. Mineral Products	Petroleum & Coal Products	Tax	Primary Metal Products	Chemicals Chemical Products	Electrical & Comm Products	Plastic Fabricated Products	Trans-port	Total
Earth Excavation	0	0	0	0	0	0	0	0	6020
Granular "A" (450 mm)	0	0	0	0	0	0	0	2142	9450
Hot-Mix HL-8 (80 mm)	0	2392	342	0	0	0	0	797	7650
Hot-Mix HL-3 (40 mm)	0	1371	215	0	0	0	0	382	4080
Concrete Curb and Gutter	2008	0	167	0	0	0	0	502	5250
Hot-Mix HL-3 Fine in Driveways	0	297	0	0	0	0	0	53	990
$CaCl_2$	0	0	0	0	345	0	0	0	460
Adjust Existing Manholes	93	0	0	601	0	0	0	0	1335
Water for Compaction	0	0	0	0	0	0	0	0	250
Relocation of Utilities, Miscellaneous	133	0	11	71	0	532	106	33	3549
Engineering Design	0	0	0	0	0	0	0	0	3123
Engineering Construction Management	0	0	0	0	0	0	0	0	2732
Column Total	2235	4060	736	672	345	532	106	3910	44889
	11	12	13	14	15	16	17	18	19

Table 3.1b/ SUP A6 – Percentages

	Total	Administration		Labour		Equipment				Non-Met. Minerals
		Overhead	Profit	Wages	Fringe	Fuel	Repairs	Insurance	Depreciation	
task										
Earth Excavation	100.0	8.0	2.0	37.4	5.6	6.1	4.7	0.9	35.2	0
Granular "A" (450 mm)	100.0	8.0	2.0	10.4	1.6	1.3	1.0	0.2	7.5	45.3
Hot-Mix HL-8 (80 mm)	100.0	8.0	2.0	11.3	1.7	1.3	1.0	0.2	7.5	20.8
Hot-Mix HL-3 (40 mm)	100.0	8.0	2.0	11.3	1.7	1.3	1.0	0.2	7.5	18.8
Concrete Curb and Gutter	100.0	8.0	2.0	23.5	3.5	1.6	1.2	0.2	9.0	0
Hot-Mix HL-3 Fine in Driveways	100.0	8.0	2.0	24.3	3.6	2.1	1.6	0.3	12.0	10.7
$CaCl_2$	100.0	8.0	2.0	8.7	1.3	0.7	0.4	0	3.7	0
Adjust Existing Manholes	100.0	8.0	2.0	33.0	4.9	0	0	0	0	0
Water for Compaction	100.0	8.0	2.0	39.2	6.0	6.0	4.4	0.8	33.6	0
Relocation of Utilities, Miscellaneous	100.0	20.0	5.0	21.8	3.2	3.2	2.5	0.5	16.7	0
Engineering Design	100.0	28.0	7.0	56.6	8.5	0	0	0	0	0
Engineering Construction Management	100.0	28.0	7.0	56.6	8.5	0	0	0	0	0
Column Total	100.0	11.6	2.9	23.8	3.6	2.0	1.5	0.3	11.3	15.0
	1	2	3	4	5	6	7	8	9	10

SUP A6 (continued)	Non-Met. Mineral Products	Petroleum & Coal Products	Tax	Primary Metal Products	Chemicals Chemical Products	Electrical & Comm Products	Plastic Fabricated Products	Transport	Total
Earth Excavation	0	0	0	0	0	0	0	0	100.0
Granular "A" (450 mm)	0	0	0	0	0	0	0	22.7	100.0
Hot-Mix HL-8 (80 mm)	0	31.3	4.5	0	0	0	0	10.4	100.0
Hot-Mix HL-3 (40 mm)	0	33.6	5.3	0	0	0	0	9.4	100.0
Concrete Curb and Gutter	38.2	0	3.2	0	0	0	0	9.6	100.0
Hot-Mix HL-3 Fine in Driveways	0	30.0	0	0	0	0	0	5.4	100.0
$CaCl_2$	0	0	0	0	75.0	0	0	0	100.0
Adjust Existing Manholes	7.0	0	0	45.0	0	0	0	0	100.0
Water for Compaction	0	0	0	0	0	0	0	0	100.0
Relocation of Utilities, Miscellaneous	3.7	0	0.3	2.0	0	15.0	3.0	0.9	100.0
Engineering Design	0	0	0	0	0	0	0	0	100.0
Engineering Construction Management	0	0	0	0	0	0	0	0	100.0
Column Total	5.0	9.0	1.6	1.5	0.8	1.2	0.2	8.7	100.0
	11	12	13	14	15	16	17	18	19

3.3/ SUP Data Development

While all the standard unit projects are described below, it is useful before turning to those descriptions to illustrate the derivation of one of the project data sets in more detail.[4] SUP A6 is again chosen for this illustration.

Standard unit project A6 involves complete reconstruction of 100 metres of roadway base and surface, reconstruction of curb and gutter, and restoration of lawns and driveways. Neither road widening nor replacement of sidewalks is assumed to be required. Total pavement width is 8.5 m. The base course is 450 mm of granular A, covered by 80 mm of HL-8 hot mix and a surface course of 40 mm of HL-3 hot mix.

It is assumed that the existing road has storm sewers and catchbasins that are in satisfactory condition. Allowance is made for the fact that the typical urban road has intersections with other urban roads along its length. Provision for minor utility relocation, and for the restoration of lawns, driveways, sidewalks and retaining structures is built into the estimates. Only minor grade changes are assumed.

Table 3.2 is a detailed breakdown of the tasks involved in this job. The total project cost, $44 889, is the amount reported at the bottom of the first column in Table 3.1a. This amount is built up from the individual tasks listed in Table 3.1a and again in Table 3.2. As shown in the latter table, each task involves a number of units of accomplishment. The cost of the task is this number times the cost per unit. These raw data were provided by professional contractors and estimators.

A second way to calculate the total cost of each task is by way of a detailed pricing of the components (administration, labour, equipment, and materials) involved in the task. In this way the total cost of a task is built up from the costs of its components. These component costs are required for entry into the input-output model. That is, for each project the row of column totals (the bottom row in Table 3.1a) provides the data entered into the input-output model.

Each component of a task can also be expressed as a percentage of the total cost of the task. It is convenient to have these percentages because, once calculated for one task, they can be used to allocate the total cost of another similar task to its components. The two approaches outlined – the

[4]For the convenience of the user, a summary description of the standard unit projects is found in Appendix C at the end of this report

unit-cost approach and the component approach – may give slightly different cost totals for each task. In the TRIM database we have used the cost totals from the first approach as the total project cost and used the percentages from the second approach to allocate these to components.

Table 3.2/ Construction Tasks – SUP A6

Task	Quantity/100 m	Unit Cost	Total Cost
1. Earth Excavation	860 m^3	\$7/m^3	\$ 6 020
2. Supply and compact Granular A to a depth of 450 mm	1 050 tonnes	9/tonne	9 450
3. Supply and place 80 mm hot-mix HL-8	170 tonnes	45/tonne	7 650
4. Supply and place 40 mm hot-mix HL-3	85 tonnes	45/tonne	4 080
5. Concrete Curb & Gutter	210 m	25/m	5 250
6. Repair Driveways (Granular A & HL-3)	55 m^2	18/m^2	990
7. Spread $CaCl_2$ for Dust Control	1 tonne	460	460
8. Adjust existing manholes	3 manholes	445/ea	1 335
9. Supply & place water for compaction	50 m^3	5/m^3	250
10. Relocation of utilities, miscellaneous			3 549
CONSTRUCTION TOTAL			39 034
11. Engineering Design	8% of construction total		3 123
12. Engineering Construction Mgmt.	7% of construction total		2 732
TOTAL PROJECT COST			\$44 889

For each of the tasks involved in the reconstruction of the roadway (per 100 m), Table 3.1b shows the percentages of total project cost assigned to each task component (i.e. to each input-output commodity class). To illustrate the development of the component costs and percentages, consider

the first task, which involves the excavation and removal of 860 m^3 of earth at an estimated cost of $7 per cubic metre. Multiplying these two numbers, the task is priced at $6 020 – this figure was characterized by our costing consultants as the average industry price for the job. However, to determine the component costs and percentages to be used to assign the $6 020 to the various input-output categories, the second approach, which involves pricing the various task components, was employed as follows.

The earth excavation is assumed to take 12 hours to complete. Labour and equipment costs for the 12-hour job are:

Labour:	Foreman & grade man	$44 per hour x 12 h	$528
	Bulldozer operator	$22 per hour x 12 h	264
	Backhoe operator	$22 per hour x 12 h	264
	7 truck drivers	7 x $18 per hour x 12 h	1 596
	Total Labour Cost		$2 652
Equipment:	Foreman's truck	$10/h x 12 h =	$120
	Bulldozer	$30/h x 12 h =	360
	Backhoe	$65/h x 12 h =	780
	7 tandem trucks	7 x $19/h x 12 h =	1 596
	Total Equipment Cost		$2 856

Cost of Administration is set at 11% of labour and equipment cost: 0.11 x $5 508 = $606

Total cost of earth excavation = Total Labour + Total Equipment + Administration
= $2 652 + $2 856 + $606 = $6 114

Since this is very close to the $6 020 calculated by the unit cost method the two numbers are viewed as consistent and the $6 114 figure is used to calculate the percentages.

Labour Percentage = (2 652 + 6 114) x 100 = 43%
Equipment Percentage = (2 856 + 6 114) x 100 = 47%
Administration Percentage = (606 + 6 114) x 100 = 10%

Each of these percentages is then further broken down into the categories shown in Table 3.1 in the following way: 87% of the total labour percentage was assigned to wages and 13% to fringe benefits; 13% of the total equipment percentage was assigned to fuel, 10% to repairs, 2% to insurance and 75% to depreciation; 80% of the administration percentage was assigned to overhead and 20% to profit. The percentages in the earth excavation line of Table 3.1b are obtained by applying the above percentages to the labour, equipment and administration percentages. When applied to the total project cost of $6 020 they generate the dollar values in the first line of Table 3.1a. For other tasks various material costs also enter the total cost. Materials are classified according to categories defined in the input-output table provided by Statistics Canada and dollar costs and percentages are entered in the appropriate columns.

Data for each of the standard unit projects (with the exception of the Provincial Highway projects) were prepared in a similar fashion.

3.4/ Rescaling

The use of 100 metres as a standard unit length was viewed as sensible by the specialists who were consulted in regard to the development of these data. An obvious question to ask is whether the numbers contained in our report and in TRIM can be rescaled to represent multiples of the standard unit. They can be, within a set of constraints. For standard unit projects related to road reconstruction or rehabilitation, the costs for longer units may be determined by straightforward rescaling. A 200 m length costs approximately twice as much, item by item, as a 100 m length. However, the numbers should not be rescaled downward in the same fashion. A 50 m length of roadway costs more than half as much as a 100 m length, due to the relatively greater proportion of fixed set-up costs in the total cost for a shorter distance. Adjustment factors are not available in this report for downward rescaling.

To build wider units of road or runway (i.e. a four-lane municipal road instead of a two-lane road), or to increase the size of other types of standard unit projects, care must be taken to sort out those tasks that are independent of the scale increase from those that are not. Typically, in the case of a roadway, the independent tasks would involve work along the edge of the road (curb and gutter, catchbasins and drains, sidewalks, driveway reconstruction, utility relocation). For example, in the case of SUP A6 the items to be prorated in going from two lanes to four are excavation, granular A, the HL-8 and HL-3 asphalt layers, and the $CaCl_2$ and water for dust control and compaction. Engineering design and engineering construction management are eight and seven percent

of the total construction cost, and will thus vary with project width. Curb and gutter, driveway repair, adjustment of manholes and relocation of utilities are fixed costs, per 100 m length of roadway.

We turn now to a description of the full list of standard unit projects contained in TRIM.

3.5/ Municipal Roads

The Ministry of Transportation provides more than $0.5 billion each year toward provision and maintenance of roadway facilities in Ontario. Special provisions for the road needs of northern municipalities, development road projects, and the connecting-link program are currently supported at about $30 million total annually. The Municipal Roads Maintenance and Construction Program (MRP) currently disburses some $550 million. Approximately 80% of this is allocated to basic needs, the remainder going to supplementary items such as bridges and equipment.

The principal MRP allocations cover a wide variety of construction projects, big and small, from minor resurfacing jobs to major four- and six-lane urban/rural arterial roads. The range is equally wide for supplementary items; in addition to bridges and equipment, subsidies are made available for such things as maintenance/storage garages, salt domes, and other primary needs. Despite this diversity of program subsidies, it is necessary to define a much narrower range of typical projects for inclusion in the TRIM database. Fortunately, since the building of normal roadways is so important, it is sensible to limit our consideration at this stage to a few standard examples of urban and rural roadway construction. Added to this is a sampling of bridge construction and rehabilitation appropriate in a municipal context.

SUP List A: Municipal Roads

1. Six-lane collector/arterial road reconstruction
2. Five-lane collector/arterial road reconstruction
3. Four-lane collector/arterial road reconstruction
4. Two-lane collector/arterial road reconstruction
5. Two-lane rural road reconstruction
6. Two-lane urban road reconstruction
7. Three-span bridge rehabilitation
8. Short-span bridge construction (over land)
9. Short-span bridge construction (over water)
10. Medium-span bridge construction (over land)
11. Medium-span bridge construction (over water)

The standard unit projects were defined following discussions with personnel from the Ministry and the Regional Municipality of Hamilton-Wentworth, as well as with private consultants and contractors involved in this type of work. Out of this process came the eleven SUPs listed above.

The prices used in the cost calculations are those expected to prevail in the Hamilton-Wentworth Region in 1987, based on regional summary data and engineering experience. Each of the roadway projects defined in the TRIM database (SUPs A1-A6) is modelled after an actual project in the Hamilton-Wentworth region, modified to reflect generic standards and configurations.

3.5.1/ Projects A1-A4: Collector/Arterial Roads

These standard unit projects are modelled after a reconstruction project on Fennell Avenue in Hamilton during 1985, with adjustments to eliminate atypical aspects of that particular project. In each case, the project is assumed to involve reconstruction of an existing road that has deteriorated to such a level that resurfacing or other such remedial work will not provide a satisfactory riding surface and/or sufficient roadway life. It is assumed that traffic is maintained on the roadway during all construction activities. All lanes are assumed to be 3.5 m in width, with standard concrete curb and gutter, a 1.5 m boulevard and a 1.5 m concrete sidewalk on each side of the road. New catchbasin drains are provided, but storm sewers are assumed not to require replacement. The roadbed is excavated, subgrade is prepared and subbase is provided to a depth of 600 mm

with granular A, covered with 120 mm of HL-5 binder asphalt, and topped with 40 mm of HL-3 surface asphalt.

For each project, the roadway length is assumed to be 100 m, although, as noted in section 3.4, the cost figures can be rescaled to longer lengths. In each case, it is assumed that some roadway widening is required to provide standard lane widths. As a result, new catchbasins are required. Intersections with urban roads along the length of the typical arterial/collector road are assumed, and an allowance equal to 15% of total construction costs is provided to cover the costs of utility relocations necessitated by roadway widening. Finally, it is assumed that only minor grade changes will occur.

Tables A1-A4 in Appendix 3A show the tasks in each project, their associated total costs, and the detailed breakdown of each of the total cost figures into component items as required for the input-output calculations.

3.5.2/ Project A5: Two-Lane Rural Road Reconstruction

This SUP is modelled after construction carried out on Milgrove Sideroad in the Town of Flamborough during 1983, again with adjustments for atypical features of that project. It involves reconstruction of 100 m of rural road, including minor widening, excavation of existing sections, ditching, and surface treatment. Traffic is assumed to be maintained on one lane at all times during construction, as would be typical on a rural regional road. The assumed roadway cross-section involves two lanes, each of width 3 m, with 1 m shoulders at each edge. The roadbed consists of 450 mm of Granular A, of which it is assumed that only 15% must be provided in the typical case. Minor widening to provide a standard road width is assumed, full ditching to a depth of 1 m is provided on both sides for proper drainage, and a cold-mix surface course is machine-laid to a depth of 40 mm, followed by a single application of surface treatment. An allowance equal to 10% of total construction costs has been included to cover miscellaneous items such as culvert extensions, new and replacement fencing, provision of barriers, and so on. Table A5 details the tasks, their associated total costs, and the breakdown of each total cost figure into its component items as required for the input-output calculations.

3.5.3/ Project A6: Two-Lane Urban Road Reconstruction

This is modelled after a roadway reconstruction project on Pleasant Avenue in the Town of Dundas in 1986, again with adjustments for atypical features of that project. Because SUP A6 was used for the detailed illustration in Section 3.3 above it is not further described here.

3.5.4/ Projects A7-A11: Municipal Bridges

The four typical projects identified for two-lane bridge construction reflect the work required for short and medium spans and take account of typical differences encountered when a bridge is built across water instead of land. The lists of tasks and associated cost breakdowns in Tables A7-A11 were prepared in the same manner as previously described, based on the professional opinions of a private consulting engineer. Because many assumptions regarding basic configuration and site-work were made, rescaling of these projects should involve detailed consideration of project components. While the model could be further developed to allow rescaling without reopening the basic cost analysis, this would require additional data collection and analyses in order to identify appropriate scale factors.

The rehabilitation project assumes a three-span structure with spans of 7.6, 18.3 and 7.6 m using reinforced concrete "T" beams. Roadway width is 9.14 m with no sidewalks. The model is based on repairs to the McBlain Bridge in Brant County.

The short-span structure over water (SUP A9) assumes a span of 17.5 m with roadway width of 8 m (two lanes) with a 1.5 m sidewalk on one side only. Footings are on limestone bedrock. The bridge is designed according to OHBDC '83 for Class C loading. These specifications are based on a bridge built at the boundary between the City of Nanticoke and the Town of Simcoe.

The medium-span bridge over water, based on a project at Pembroke, assumes a three-span configuration of 27 m, 30 m and 27 m. The roadway width (two lanes) is 9.5 m with no sidewalk. The bridge is made of precast girders with a reinforced concrete deck (waterproofed and asphalt wearing surface). Footings are short piles bearing on bedrock. Again this bridge is designed according to OHBDC '83 for Class C loading.

SUPs A8 and A10 are similar structures built over land, differing only in costs associated with constructing foundations on land rather than in water. The cost detail on all of the Municipal Road projects is contained in Tables A1-A11 in Appendix 3A.

3.6/ Airports

Through its Aviation Office, the Ministry provides technical guidance and financial assistance to municipalities in Ontario not served by Federal airports. The Municipal Airport Development Program (MADP) assists 46 airports across the province (except in remote areas, where help is provided under a different program). It is also expected that at least four new airports will be developed within the next five years.

MADP is essentially a three-phase effort. Phase 1, provision of basic minimum required facilities, is nearing completion; phase 2 is underway, providing for safety upgrades and some capacity improvements; under phase 3, regular improvements to capacity will be implemented as demand warrants and funding enables. Construction and operating subsidies under the program are currently about $4.6 million and $0.8 million per year respectively.

In the context of this project it is the construction subsidy program that is of interest. This program "... is intended to facilitate development of the Province-wide municipal airport system by providing financial assistance to municipalities for the implementation of airport-related facilities including the purchase of required property." The program "... covers almost all the facilities, equipment and other necessities for constructing, modifying or expanding a municipal airport .... "[5] Table 3.3 shows the expenditures projected for the period 1986-90 in the DelCan report. Table 3.4, which extracts the items upon which most of the expenditure will be made, is helpful in regard to identifying areas in which standard unit projects are required.

About 72% of projected expenditure on Ontario municipal airports is expected to be applied to the provision of air-side pavements. This suggests that airport pavements should be an important component of our SUP database in the aviation sector. As indicated in the SUP list B, we have also accounted for navigation aids (Navaid) and access roads.

A basic minimal airport facility is defined as one having up to 3 500 feet of runway, with up to 80 000 square feet of apron space. Some municipal facilities require more or less pavement than this and subsidies to build them vary widely. Note also that municipal airport projects subsidized under MADP are very often improvements of existing airports, rather than construction of entirely new ones.

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[5]DelCan, Evaluation of the Municipal Airport Development Program. Toronto, Ontario, 1986.

Table 3.3/ Distribution of Projected Capital Spending for 1986-90

ELIGIBLE PROJECTS	1986		1987		1988		1989		1990		SUB-TOTALS		TOTAL PROJECTED EXPENDITURES	% DISTR
	T.E.C.	SHARE/FF	T.E.C.	SHARE/FF	T.E.C.	SHARE/FF	T.E.C.	SHARE/FF	T.E.C.	SHARE/FF	T.E.C.	SHARE/FF		
STUDIES													$170,000	0.4
Role / Needs Study	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		
Site / Master Plan	$135,000	$117,500	$15,000	$5,000	$0	$0	$0	$0	$0	$0	$170,000	$126,500		
RUNWAY / VISUAL AIDS													$25,486,100	59.0
12,500 ft./ Vis.Aids	$4,296,200	$2,227,600	$2,775,200	$2,022,200	$2,573,600	$1,978,900	$1,768,800	$1,243,000	$2,213,600	$1,757,500	$13,633,500	$10,430,200		
11,500 ft./ Vis.Aids	$1,375,500	$700,000	$2,863,700	$1,763,000	$1,970,000	$1,100,000	$527,500	$368,000	$39,200	$0	$7,002,600	$4,012,600		
Secondary Runway	$0	$0	$0	$0	$400,000	$200,000	$100,000	$50,000	$3,100,000	$1,650,000	$3,600,000	$1,900,000		
L.I. Appr. Lights	$0	$0	$1,110,000	$5,000	$0	$0	$0	$0	$0	$0	$1,110,000	$5,000		
R.I. Appr. Lights	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		
Heliport	$0	$0	$0	$0	$0	$0	$70,000	$10,000	$170,000	$90,000	$140,000	$100,000		
APRON													$3,833,400	7.9
< 80,000 sq.ft.	$526,000	$44,000	$84,900	$67,900	$0	$0	$170,000	$135,000	$90,000	$72,000	$490,900	$320,700		
> 80,000 sq.ft.	$14,000	$7,000	$320,000	$160,000	$200,000	$150,000	$0	$0	$0	$0	$534,000	$317,000		
Tie-down Area	$11,500	$6,200	$57,000	$28,500	$825,000	$670,000	$135,000	$67,500	$940,000	$720,000	$1,998,500	$1,500,700		
Non-public	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		
TAXIWAYS													$2,630,000	5.1
Term. Apron / Runway	$76,500	$61,200	$56,500	$45,200	$0	$0	$60,000	$48,000	$0	$0	$193,000	$154,400		
Parallel	$85,000	$42,500	$210,000	$105,000	$820,000	$410,000	$117,000	$450,500	$200,000	$100,000	$2,232,000	$1,116,000		
To GA Area	$13,000	$7,500	$40,000	$20,000	$100,000	$50,000	$50,000	$25,000	$0	$0	$295,000	$102,500		
Non-public	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		
ROADS													$940,700	2.2
Entrance to Terminal	$31,600	$25,300	$200,200	$166,600	$80,000	$64,000	$50,000	$40,000	$0	$0	$361,900	$295,900		
To GA Area	$20,000	$14,000	$40,000	$20,000	$0	$0	$0	$0	$0	$0	$75,000	$30,000		
Airport Service Road	$0	$0	$100,000	$50,000	$0	$0	$0	$0	$175,000	$87,500	$275,000	$137,500		
Non-public	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		
ATB Parking	$17,000	$13,200	$0	$0	$50,000	$25,000	$160,000	$80,000	$0	$0	$227,000	$126,200		
TERMINAL BUILDING													$1,909,500	4.4
Public/Paint. areas	$74,500	$59,600	$303,000	$242,400	$1,100,000	$700,000	$200,000	$160,000	$10,000	$8,000	$1,687,500	$1,110,000		
Ords/Loose/Baggage	$22,000	$17,000	$0	$0	$0	$0	$0	$0	$0	$0	$22,000	$17,000		
Non-public furniture	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		
MAINTENANCE GARAGE													$940,000	2.2
Veh.area(1,600sq.ft.	$150,000	$100,000	$240,000	$156,000	$250,000	$200,000	$130,000	$152,000	$0	$0	$840,000	$616,000		
Veh.area(1,600sq.ft.	$0	$0	$0	$0	$0	$0	$0	$0	$100,000	$50,000	$100,000	$50,000		
Off.,lunches,showers	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		
Furniture,hand tools & portable equipment	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		
MOBILE EQUIPMENT													$85,000	0.2
Equip. Aquisition	$0	$0	$15,000	$14,000	$0	$0	$0	$0	$30,000	$24,000	$45,000	$40,000		
Parts Procurement	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		
BUILDINGS / LOT DEV.													$375,000	0.9
Hangars	$56,000	$0	$0	$0	$0	$0	$80,000	$40,000	$0	$0	$136,000	$40,000		
Lease Lots	$85,000	$30,000	$0	$0	$100,000	$50,000	$0	$0	$54,000	$0	$239,000	$80,000		
AVIATION FUEL INSTAL.	$295,000	$216,000	$159,000	$127,200	$100,000	$80,000	$150,000	$120,000	$0	$0	$804,000	$543,200	$804,000	1.9
SERVICES													$136,500	0.3
To Terminal/par.area	$55,500	$44,400	$0	$0	$0	$0	$0	$0	$0	$0	$55,500	$44,400		
To GA Area	$41,000	$20,500	$10,000	$5,000	$30,000	$15,000	$0	$0	$0	$0	$81,000	$40,500		
FENCING													$106,300	0.2
Terminal area	$17,100	$13,700	$0	$0	$0	$0	$0	$0	$0	$0	$17,100	$13,700		
Other Public areas	$44,100	$27,200	$45,000	$22,500	$0	$0	$0	$0	$0	$0	$89,100	$49,700		
Private use areas	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		
LAND													$4,447,000	10.3
Main Runway (5000 ft	$4,422,000	$3,133,000	$0	$0	$0	$0	$0	$0	$0	$0	$4,422,000	$3,133,000		
Secondary Runways	$25,000	$20,000	$0	$0	$0	$0	$0	$0	$0	$0	$25,000	$20,000		
Term.area & access rd	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		
OBSTRUCTION ZONING													$15,000	0.0
Prop.Al.limits/By-law	$15,000	$12,000	$0	$0	$0	$0	$0	$0	$0	$0	$15,000	$12,000		
Prop.N.E.F. contours	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		
Hearings/Impl.By-laws	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		
RUNWAYS	$27,700	$12,000	$0	$0	$0	$0	$2,000,000	$800,000	$125,000	$0	$2,052,700	$812,000	$2,052,700	4.8
VHF/UHF RADIO	$9,600	$7,700	$0	$0	$0	$0	$0	$0	$2,000	$1,600	$11,600	$9,300	$11,600	0.0
NET EQUIPMENT	$0	$0	$10,000	$8,000	$0	$0	$0	$0	$0	$0	$10,000	$8,000	$10,000	0.0
MOBILE RADIOS	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	0.0
TOTALS	$11,586,900	$8,180,000	$9,116,500	$5,233,400	$8,720,600	$5,868,900	$6,570,300	$3,906,000	$7,131,100	$4,568,600	$43,171,500	$27,750,500	$43,001,500	99.6

T.E.C. refers to total estimated cost
Source: DelCan Report

Table 3.4

Provincial Airport Subsidies – Selected Categories

Facility	% of Total	Cumulative %
runways/visual aids	59.0	59.0
aprons	7.0	66.0
taxiways	6.1	72.1
terminals	4.4	76.5
navaids	4.8	81.3
maintenance garages	2.2	83.5
roads	2.2	85.7

To cover the range of small-medium-large, the standard projects considered were assumed to have runways of 2 000 ft, 3 500 ft, and 5 000 ft, as shown in SUP List B below. Projects of three types have been included for each of these lengths: a major runway upgrade, a minor upgrade and an upgrade involving only the improvement of navigation aids. Again, the numbers used correspond to those in the TRIM computer program.

Discussions with personnel at DelCan, an important supplier of expertise in airport design, informed us of a project currently in progress which is representative of municipal airport projects in southern Ontario: the proposed upgrading of Stratford Municipal Airport. Pre-tender estimates for that project were provided by DelCan. Using these data as a starting point, each component of the work was scaled to represent a corresponding proportion of work required for a typical 1 000 metre runway.

SUP List B: Aviation

1. Major upgrade of a 2 000 ft runway
2. Major upgrade of a 3 500 ft runway
3. Major upgrade of a 5 000 ft runway
4. Navaid upgrade of a 2 000 ft runway
5. Navaid upgrade of a 3 500 ft runway
6. Navaid upgrade of a 5 000 ft runway
7. Minor upgrade of a 2 000 ft runway
8. Minor upgrade of a 3 500 ft runway
9. Minor upgrade of a 5 000 ft runway
10. Airport access road, 200 metres long
11. Airport access road, 500 metres long

The nine SUPs involving runways were then based on these estimates, taking account of certain fixed components in each project that do not depend on runway length.[6] For that reason, costs and economic impacts for the three different runway lengths do not vary proportionally with the length of the runway.

For all eleven standard unit projects the input prices assumed were those projected to prevail in the Hamilton-Wentworth region in 1987. Adjustments to reflect different prices in other areas of the Province could be derived from data available from the Ministry estimating office.

3.6.1/ Airport Projects B1-B3: Major Runway Upgrades

A major upgrade covers approximately 77% of the total budgeted items for eligible projects as listed in Table 3.3. The projects involve: complete rebuilding of the runways and taxiways; drainage; new fencing and landscaping (including tree planting); complete electrical, lighting, and navaid upgrading; installation of meteorological equipment; refurbishing of the air terminal building; new fuel tanks; and connections to external power sources. Runways are the standard 30 metre width.

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[6]Runway lengths and related measures are presented in Imperial units because, from the DelCan report and other sources, that appears to be the conventional way to express them . On the other hand, our engineering cost data were prepared in Metric units. An exact conversion factor was applied.

3.6.2/ Airport Projects B4-B6: Navaid Upgrades

This type of improvement of an existing facility presupposes the existence of a serviceable runway, but one that is in need of new wiring, lighting, visual and instrument landing systems, and meteorological equipment. Trenching for cable installation and connection to external power sources are also included.

3.6.3/ Airport Projects B7-B9: Minor Runway Upgrades

A minor runway upgrade (SUPs B7-B9) presupposes the existence of an existing runway in reasonable condition (i.e. not in need of complete reconstruction), but one that may be narrower or shorter than is warranted by the type of traffic the airport handles. This type of project does not involve any new facilities, but could involve some widening or lengthening of an existing runway. The runway is resurfaced; new subdrains and seeding and mulching of the periphery are provided.

3.6.4/ Airport Projects B10 and B11: Access Roads

The last two typical projects (SUPs B10 and B11) involve the construction or rebuilding of access roads to the air terminal. Both are built to the same construction standard, but are of different lengths. The projects are identical except in length to SUP A5, the two-lane rural road discussed previously under Municipal Roads. Briefly, it involves a complete rebuild of an existing road to a three-metre lane width. Included are minor widening, excavation and the repair of existing sections, ditching, and surface treatment.

A detailed listing of the construction activities, with associated breakdowns of total cost by task, are shown for the eleven standard unit airport projects in Tables B1-B11 in Appendix 3A.

3.7/ Provincial Highways

The Provincial Highways program differs from the Municipal Roads and other programs in that the Ministry initiates projects, grants contracts directly, supplies some materials and supervises the projects. For this reason, detailed project information is available within the Ministry. In fact, input data similar to those required by TRIM had already been collected and organized according to input-output system requirements for use in an earlier impact model for Provincial Highway projects. This set of data, put together for the Micro-Economic Impact Evaluation System (MIES),

was based on a representative sample of ten types of projects.[7] It has been adapted for use with TRIM. The projects included are listed below. Because the original definition of these projects, and the development of data for them, was done within the Ministry, our description of them is brief, focusing mainly on the adaptation of the data so they will be consistent with the TRIM database.[8]

Sup List C: Provincial Highways

1. New construction – unpaved, two lanes
2. New construction – paved, four lanes
3. Reconstruction – paved, two lanes
4. Reconstruction – paved (with rock), two lanes
5. Resurfacing, two lanes
6. Resurfacing with recycled hot mix (less than four inches), two lanes
7. Post-tensioned concrete structure (cast in place)
8. Bridge deck – latex modified concrete overlay
9. Bridge deck repairs – latex patching with asphalt overlay
10. Major widening (no structures)

SUPs C1-C6 and C10 refer to a unit of highway 1 km long. SUPs C7-C9 refer to 1 m^2.

The data for each of the above SUPs was based on a sample of eight to ten projects drawn from around the province during the 1981/82 fiscal year. The data were expressed as fractions of the $1 million spent on each project, as opposed to being based on a unit length or size as was done with the other SUPs. In order to express projects in terms of physical units, information was taken from the Cost Per Mile of Highway Construction (April 1982) prepared by the Estimating Office of the Ministry, in consultation with Ministry Personnel. The Ministry also provided information on bridge deck construction and repair. Project input data was then scaled to a per-kilometre or per-square-metre basis.

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[7]Publications describing MIES, an OJT & CRP project completed in 1982, are available from the Research and Development Branch, MTO.

[8]A brief discussion of the similarities and differences between MIES and TRIM is found in Appendix B at the end of this report.

A second adjustment to the data was necessary in order to change input costs in 1981/82 values to 1986/87 values. This adjustment was based on the price indexes for construction inputs which are used as a part of the model (and described in Appendix A). Whenever they were available, price indexes for particular commodities were used. For example, a price index for calcium chloride was based on unit price data supplied by the Ministry, as was an index for construction equipment rental. All materials, labour, fuel and equipment costs were inflated to 1986/87 values and then "grossed-up" to allow for 10% overhead and 5% profit, as assumed in the original MIES data.

Equipment costs were a matter of special concern since they included a composite "Cost-Own" item which contains insurance, storage, license and interest costs. This item was broken down using information provided by the Estimating Office. This breakdown is shown below.

Allocation of Equipment "Cost-Own" as a Percentage of the Total

Item	On-Road	Off-Road
Interest	42.5	70.0
Insurance	32.2	10.0
License	12.5	15.0
Storage	12.8	5.0
Total	100.0	100.0

The cost breakdown for each Provincial Highway SUP, expressed in 1986/87 values, is shown in Appendix 3A. Because SUP costs were not broken down by task in MIES, only the total cost for each product or service category is given. Thus SUPs C1-C10 are combined into one Table.

The cost shares shown for SUPs C1-C10 differ from those in the original MIES data because relative prices of the various inputs have changed since 1981. For instance, the price of asphalt and fuel was almost constant over the 1981-86 period, while other input prices have been rising.

Finally, we should note that the item "Overhead" does not correspond to any single commodity in the input-output system. This item was broken down into input-output commodities according to the proportions of overhead commodities, such as office, business services, etc., used by the

construction industry in Ontario (as reported in the input-output data). The proportions used are shown below.

Allocation of Overhead

Commodity	% of Total
Communications Services	2.5
Utilities	0.8
Insurance	15.9
Business Services	40.0
Personal Services	16.5
Operating, Office, etc.	19.3
Travel, Advertising	5.0
Total	100.0

This allocation was also used for input data from other Ministry programs.

3.8/ Provincial Transit

The Ministry of Transportation commits very extensive financial resources to public ground transportation services in the Toronto region. In the 1985-86 fiscal year, capital and construction spending in the Provincial Transit Program were $18.4 million (not counting expenditures on GO-ALRT). With capital programs directed to improving existing services on GO Transit and to expanding the whole system, there is a wide range of possible standard unit projects that could be built into TRIM. The building of terminal structures, parking lots at commuter stations, bus and train maintenance facilities, the purchasing or rebuilding of locomotives, the provision of dedicated track and numerous other aspects of improving or expanding service could be modelled.

In this phase of the development of TRIM our research team decided to limit its consideration of provincial transit facilities to peripheral services (parking lot facilities for commuters), rather than attempting to deal with the large central infrastructure of the provincial transit service (i.e. the bus and train service itself). Data collection in this area is somewhat complicated due to the varied types of capital involved and the complex pattern of responsibilities that exists; for example, GO buys some of its capital services from the railways. After responding to the initial version of

TRIM, Ministry personnel may wish to decide whether additional standard unit projects should be defined to represent GO Transit; the project team would be willing to respond to such a request.

3.8.1/ Provincial Transit Projects D1 and D2: Suburban Parking Lots

SUP D1 is a suburban parking lot built for 200 vehicles. It is assumed to have a 75 mm asphalt coating, full drainage, curbing and full illumination. SUP D2 is a more limited parking facility built to hold 100 cars. It has a 50 mm asphalt coating, no curbs, no drainage (except some ditching, included in the "Miscellaneous" task in Table D2) and minimal illumination, consisting of one luminaire at the lot entrance.

The cost breakdowns for these parking lots shown in Tables D1 and D2 were derived from information available in the Municipal Roads data set. Consistent with requirements for input-output analysis, land cost was not included.

3.9 Municipal Transit

Extensive subsidies are provided by Ministry to aid Ontario cities in their efforts to provide high quality urban passenger transportation. In the 1985-86 fiscal year capital and construction expenditures under the Municipal Transit Program amounted to $207.7 million. A wide variety of capital equipment and infrastructure is financed through these subsidies.

A key aspect of deciding what projects are important in the urban transit area is to recognize that rapid transit facilities and normal bus transit services are best considered separately. If one merely looks at the breakdown of total Ministry expenditures, subsidies for rapid transit (so far undertaken only in Toronto and Ottawa) will dominate. Yet expenditures on normal bus systems, while smaller, are enormously important in all urban areas, and especially in cities without rapid transit systems. For this reason we have approached the two parts of Municipal Transit separately.

In relation to normal surface transit, SUP E1 is a complex service and administration facility for transit buses. It is described below. In relation to rapid transit, preliminary data that will ultimately allow the preparation of standard unit projects in the subway area are to be provided to us by officials in the Construction Department of the Toronto Transit Commission. The extent of this information is not known at the time of preparation of this report. We expect at minimum, however, to define two central standard unit projects: a unit of subway construction and an under-

ground station, both built by the cut-and-cover method. Since such structures are so complex, it may be useful to subdivide these two projects into a number of typical projects, thus allowing for more variation in system specifications.

3.9.1/ Project E1: Municipal Transportation Centre

SUP E1 was developed through discussions with an architectural firm experienced in designing service buildings for urban transit systems. Their cost consultant was retained to provide the recipe and cost breakdown for a transportation centre of the type currently being tendered in Hamilton. The total cost of the facility is $18.4 million, or $56 per square metre.

The facility consists of three parts: (i) an administration and office building, with two floors, each of 2 540 m^2, and a basement of 630 m^2; (ii) a bus storage area housing 150 buses with a floor area of 10 550 m^2; and (iii) a fully-equipped maintenance area of 11 700 m^2. Lunch rooms and clerical offices are provided in the storage and maintenance areas.

Architects normally develop cost estimates in categories defined by the construction trades contracted to carry out the work. For this reason Table E1 in Appendix 3A shows costs broken down by trade, rather than by task as in the other SUPs.

The first heading, General Allowance, covers hardware, contingencies, and inspection. General Requirements includes project coordination and layout, surveying, full bonding (100% plus labour and materials), building permits and surveying, and liability insurance, as well as all temporary on-site facilities.

Sitework includes excavation, hauling, trenching, drainage, fencing, landscaping, curbing and paving. Concrete and Masonry work are itemized separately, as are Metals, including structural steel, and Carpentry. Insulation, water proofing, siding and roofing are the major components of the item labelled Thermal and Moisture Proofing. Windows and Doors constitute a separate category.

Finishes include drywall, tile, ceiling panels, flooring, carpeting and painting. Specialities include signs and symbols, wardrobe lockers, shelving, toilet accessories and compartments, telephone enclosures, and even a flag pole. Equipment includes hydraulic hoists, a crane and mono rail, a paint spray booth, bus washing equipment, a brake drum lathe and numerous other items.

There is provision under the heading Conveying Systems for a passenger elevator, hoists, mono rails and jib cranes. The Mechanical item accounts for plumbing, including fire protection, oil storage tanks, heating and cooling, an air handling unit and precision controls. Under the heading Electrical, the data account for services, distribution, lighting, communication systems, alarm and detection equipment, and a snow-melting heater.

Appendix 3A

Cost Data for
Standard Unit Projects

Standard Unit Project A1 Six-Lane Collector/Arterial Road Reconstruction	Total	Administration		Labour			Equipment			Non-Met. Minerals
		Overhead	Profit	Wages	Fringe	Fuel	Repairs	Insurance	Depreciation	
task										
Excavate Existing Road Base; Grade and Shape Subbase	16088	1287	322	6018	899	983	756	151	5671	0
Granular "A" Base 600 mm Depth	34425	2754	689	3594	537	448	344	69	2582	15606
Additional Excavation for Soft Subgrade	2160	173	43	319	48	205	158	32	1183	0
Granular Backfill for Soft Spot Excavation	4680	374	94	611	91	176	136	27	1018	1435
Burn and Plane Asphalt 25 mm by 600 mm	200	16	4	104	16	8	6	1	45	0
Adjust Manholes, Catchbasins, Valve Chambers	850	68	17	407	61	0	0	0	0	0
Clean Manholes	400	32	8	313	47	0	0	0	0	0
Supply and Place 120 mm HL-5 Binder Asphalt	35775	2862	716	4048	605	465	358	72	2683	9055
Supply and Place 40 mm HL-3 Surface Asphalt	15840	1267	317	1792	268	206	158	32	1188	2969
Construct Single Catchbasin	1700	136	34	133	20	20	15	3	115	23
Construct Double Catchbasin	2600	208	52	204	30	20	16	3	117	17
Construct 250 mm Curb Drains	3900	312	78	1493	223	152	117	23	878	130
Construct Curb and Gutter	5125	410	103	1204	180	80	62	12	461	0
Construct Sidewalk 1.5 m Wide	9840	787	197	2996	448	77	59	12	443	459
Supply and Place 50 mm HL-3 Asphalt in Boulevards	4575	366	92	1114	167	95	73	15	549	488
Supply and Place $CaCl_2$ for Dust Control	600	48	12	52	8	4	3	1	23	0
Supply and Place Subdrains	1845	148	37	610	91	41	31	6	235	0
Relocation of Utilities, Miscellaneous	15612	3122	781	3396	507	507	390	78	2927	0
Engineering Design	12497	3499	875	7067	1056	0	0	0	0	0
Engineering Construction Management	10935	3062	765	6184	924	0	0	0	0	0
Column Total	179647	20932	5233	41657	6225	3487	2682	536	20117	30183
	1	2	3	4	5	6	7	8	9	10

SUP A1 (continued)	Non-Met. Mineral Products	Petroleum & Coal Products	Tax	Primary Metal Products	Chemicals Chemical Products	Electrical & Comm Products	Plastic Fabricated Products	Transport	Total
Excavate Existing Road Base; Grade and Shape Subbase	0	0	0	0	0	0	0	0	16088
Granular "A" Base 600 mm Depth	0	0	0	0	0	0	0	7803	34425
Additional Excavation for Soft Subgrade	0	0	0	0	0	0	0	0	2160
Granular Backfill for Soft Spot Excavation	0	0	0	0	0	0	0	718	4680
Burn and Plane Asphalt 25 mm by 600 mm	0	0	0	0	0	0	0	0	200
Adjust Manholes, Catchbasins, Valve Chambers	298	0	0	0	0	0	0	0	850
Clean Manholes	0	0	0	0	0	0	0	0	400
Supply and Place 120 mm HL-5 Binder Asphalt	0	8789	1598	0	0	0	0	4528	35775
Supply and Place 40 mm HL-3 Surface Asphalt	0	5322	836	0	0	0	0	1485	15840
Construct Single Catchbasin	578	0	0	612	0	0	0	11	1700
Construct Double Catchbasin	858	0	0	1066	0	0	0	9	2600
Construct 250 mm Curb Drains	429	0	0	0	0	0	0	65	3900
Construct Curb and Gutter	1960	0	163	0	0	0	0	490	5125
Construct Sidewalk 1.5 m Wide	3100	0	258	0	0	0	0	1005	9840
Supply and Place 50 mm HL-3 Asphalt in Boulevards	0	1373	0	0	0	0	0	244	4575
Supply and Place $CaCl_2$ for Dust Control	0	0	0	0	450	0	0	0	600
Supply and Place Subdrains	0	0	0	0	0	0	646	0	1845
Relocation of Utilities, Miscellaneous	585	0	49	312	0	2342	468	146	15612
Engineering Design	0	0	0	0	0	0	0	0	12497
Engineering Construction Management	0	0	0	0	0	0	0	0	10935
Column Total	7808	15484	2905	1990	450	2342	1114	16503	179647
	11	12	13	14	15	16	17	18	19

Standard Unit Project A2 Five-Lane Collector/Arterial Road Reconstruction	Total	Administration		Labour			Equipment			Non-Met. Minerals
		Overhead	Profit	Wages	Fringe	Fuel	Repairs	Insurance	Depreciation	
task										
Excavate Existing Road Base; Grade and Shape Subbase	13406	1073	268	5015	749	819	630	126	4726	0
Granular "A" Base 600 mm Depth	28688	2295	574	2995	448	373	287	57	2152	13005
Additional Excavation for Soft Subgrade	1800	144	36	266	40	171	131	26	986	0
Granular Backfill for Soft Spot Excavation	3900	312	78	509	76	147	113	23	848	1196
Burn and Plane Asphalt 25 mm by 600 mm	200	16	4	104	16	8	6	1	45	0
Adjust Manholes, Catchbasins, Valve Chambers	850	68	17	407	61	0	0	0	0	0
Clean Manholes	400	32	8	313	47	0	0	0	0	0
Supply and Place 120 mm HL-5 Binder Asphalt	29813	2385	596	3372	504	388	298	60	2236	7546
Supply and Place 40 mm HL-3 Surface Asphalt	13200	1056	264	1493	223	172	132	26	990	2475
Construct Single Catchbasin	1700	136	34	133	20	20	15	3	115	23
Construct Double Catchbasin	2600	208	52	204	30	20	16	3	117	17
Construct 250 mm Curb Drains	3900	312	78	1493	223	152	117	23	878	130
Construct Curb and Gutter	5125	410	103	1204	180	80	62	12	461	0
Construct Sidewalk 1.5 m Wide	9840	787	197	2996	448	77	59	12	443	459
Supply and Place 50 mm HL-3 Asphalt in Boulevards	4575	366	92	1114	167	95	73	15	549	488
Supply and Place $CaCl_2$ for Dust Control	500	40	10	44	7	3	3	1	19	0
Supply and Place Subdrains	1845	148	37	610	91	41	31	6	235	0
Relocation of Utilities, Miscellaneous	15612	3122	781	3396	507	507	390	78	2927	0
Engineering Design	11036	3090	773	6241	933	0	0	0	0	0
Engineering Construction Management	9657	2704	676	5461	816	0	0	0	0	0
Column Total	158646	18704	4676	37370	5584	3072	2363	473	17725	25339
	1	2	3	4	5	6	7	8	9	10

SUP A2 (continued)	Non-Met. Mineral Products	Petroleum & Coal Products	Tax	Primary Metal Products	Chemicals Chemical Products	Electrical & Comm Products	Plastic Fabricated Products	Transport	Total
Excavate Existing Road Base; Grade and Shape Subbase	0	0	0	0	0	0	0	0	13406
Granular "A" Base 600 mm Depth	0	0	0	0	0	0	0	6503	28688
Additional Excavation for Soft Subgrade	0	0	0	0	0	0	0	0	1800
Granular Backfill for Soft Spot Excavation	0	0	0	0	0	0	0	598	3900
Burn and Plane Asphalt 25 mm by 600 mm	0	0	0	0	0	0	0	0	200
Adjust Manholes, Catchbasins, Valve Chambers	298	0	0	0	0	0	0	0	850
Clean Manholes	0	0	0	0	0	0	0	0	400
Supply and Place 120 mm HL-5 Binder Asphalt	0	7324	1332	0	0	0	0	3773	29813
Supply and Place 40 mm HL-3 Surface Asphalt	0	4435	697	0	0	0	0	1237	13200
Construct Single Catchbasin	578	0	0	612	0	0	0	11	1700
Construct Double Catchbasin	858	0	0	1066	0	0	0	9	2600
Construct 250 mm Curb Drains	429	0	0	0	0	0	0	65	3900
Construct Curb and Gutter	1960	0	163	0	0	0	0	490	5125
Construct Sidewalk 1.5 m Wide	3100	0	258	0	0	0	0	1005	9840
Supply and Place 50 mm HL-3 Asphalt in Boulevards	0	1373	0	0	0	0	0	244	4575
Supply and Place $CaCl_2$ for Dust Control	0	0	0	0	375	0	0	0	500
Supply and Place Subdrains	0	0	0	0	0	0	646	0	1845
Relocation of Utilities, Miscellaneous	585	0	49	312	0	2342	468	146	15612
Engineering Design	0	0	0	0	0	0	0	0	11036
Engineering Construction Management	0	0	0	0	0	0	0	0	9657
Column Total	7808	13132	2499	1990	375	2342	1114	14081	158646
	11	12	13	14	15	16	17	18	19

Standard Unit Project A3 Four-Lane Collector/Arterial Road Reconstruction	Total	Administration		Labour		Fuel	Equipment			Non-Met. Minerals
		Overhead	Profit	Wages	Fringe		Repairs	Insurance	Depreci-ation	
task										
Excavate Existing Road Base; Grade and Shape Subbase	10725	858	215	4012	600	655	504	101	3781	0
Granular "A" Base 600 mm Depth	22950	1836	459	2396	358	298	230	46	1721	10404
Additional Excavation for Soft Subgrade	1440	115	29	213	32	137	105	21	788	0
Granular Backfill for Soft Spot Excavation	3120	250	62	407	61	118	90	18	679	957
Burn and Plane Asphalt 25 mm by 600 mm	200	16	4	104	16	8	6	1	45	0
Adjust Manholes, Catchbasins, Valve Chambers	850	68	17	407	61	0	0	0	0	0
Clean Manholes	400	32	8	313	47	0	0	0	0	0
Supply and Place 120 mm HL-5 Binder Asphalt	23850	1908	477	2697	403	310	239	48	1789	6037
Supply and Place 40 mm HL-3 Surface Asphalt	10560	845	211	1194	178	137	106	21	792	1980
Construct Single Catchbasin	1700	136	34	133	20	20	15	3	115	23
Construct Double Catchbasin	2600	208	52	204	30	20	16	3	117	17
Construct 250 mm Curb Drains	3900	312	78	1493	223	152	117	23	878	130
Construct Curb and Gutter	5125	410	103	1204	180	80	62	12	461	0
Construct Sidewalk 1.5 m Wide	9840	787	197	2996	448	77	59	12	443	459
Supply and Place 50 mm HL-3 Asphalt in Boulevards	4575	366	92	1114	167	95	73	15	549	488
Supply and Place $CaCl_2$ for Dust Control	400	32	8	35	5	3	2	0	15	0
Supply and Place Subdrains	1845	148	37	610	91	41	31	6	235	0
Relocation of Utilities, Miscellaneous	15612	3122	781	3396	507	507	390	78	2927	0
Engineering Design	9575	2681	670	5415	809	0	0	0	0	0
Engineering Construction Management	8380	2346	587	4739	708	0	0	0	0	0
Column Total	137647	16476	4119	33083	4943	2658	2045	409	15334	20494
	1	2	3	4	5	6	7	8	9	10

SUP A3 (continued)	Non-Met. Mineral Products	Petroleum & Coal Products	Tax	Primary Metal Products	Chemicals Chemical Products	Electrical & Comm Products	Plastic Fabricated Products	Trans-port	Total
Excavate Existing Road Base; Grade and Shape Subbase	0	0	0	0	0	0	0	0	10725
Granular "A" Base 600 mm Depth	0	0	0	0	0	0	0	5202	22950
Additional Excavation for Soft Subgrade	0	0	0	0	0	0	0	0	1440
Granular Backfill for Soft Spot Excavation	0	0	0	0	0	0	0	478	3120
Burn and Plane Asphalt 25 mm by 600 mm	0	0	0	0	0	0	0	0	200
Adjust Manholes, Catchbasins, Valve Chambers	298	0	0	0	0	0	0	0	850
Clean Manholes	0	0	0	0	0	0	0	0	400
Supply and Place 120 mm HL-5 Binder Asphalt	0	5859	1065	0	0	0	0	3018	23850
Supply and Place 40 mm HL-3 Surface Asphalt	0	3548	557	0	0	0	0	990	10560
Construct Single Catchbasin	578	0	0	612	0	0	0	11	1700
Construct Double Catchbasin	858	0	0	1066	0	0	0	9	2600
Construct 250 mm Curb Drains	429	0	0	0	0	0	0	65	3900
Construct Curb and Gutter	1960	0	163	0	0	0	0	490	5125
Construct Sidewalk 1.5 m Wide	3100	0	258	0	0	0	0	1004	9840
Supply and Place 50 mm HL-3 Asphalt in Boulevards	0	1373	0	0	0	0	0	244	4575
Supply and Place $CaCl_2$ for Dust Control	0	0	0	0	300	0	0	0	400
Supply and Place Subdrains	0	0	0	0	0	0	646	0	1845
Relocation of Utilities, Miscellaneous	585	0	49	312	0	2342	468	146	15612
Engineering Design	0	0	0	0	0	0	0	0	9575
Engineering Construction Management	0	0	0	0	0	0	0	0	8380
Column Total	7808	10780	2093	1990	300	2342	1114	11659	137647
	11	12	13	14	15	16	17	18	19

Standard Unit Project A4 Two-Lane Collector/Arterial Road Reconstruction	Total	Administration		Labour		Equipment				Non-Met. Minerals
		Overhead	Profit	Wages	Fringe	Fuel	Repairs	Insurance	Depreci-ation	
task										
Excavate Existing Road Base; Grade and Shape Subbase	5363	429	107	2006	300	328	252	50	1890	0
Granular "A" Base 600 mm Depth	11475	918	230	1198	179	149	115	23	861	5202
Additional Excavation for Soft Subgrade	720	58	14	106	16	68	53	11	394	0
Granular Backfill for Soft Spot Excavation	1560	125	31	204	30	59	45	9	339	478
Burn and Plane Asphalt 25 mm by 600 mm	200	16	4	104	16	8	6	1	45	0
Adjust Manholes, Catchbasins, Valve Chambers	850	68	17	407	61	0	0	0	0	0
Clean Manholes	400	32	8	313	47	0	0	0	0	0
Supply and Place 120 mm HL-5 Binder Asphalt	11925	954	239	1349	202	155	119	24	894	3018
Supply and Place 40 mm HL-3 Surface Asphalt	5280	422	106	597	89	69	53	11	396	990
Construct Single Catchbasin	1700	136	34	133	20	20	15	3	115	23
Construct Double Catchbasin	2600	208	52	204	30	20	16	3	117	17
Construct 250 mm Curb Drains	3900	312	78	1493	223	152	117	23	878	130
Construct Curb and Gutter	5125	410	103	1204	180	80	62	12	461	0
Construct Sidewalk 1.5 m Wide	9840	787	197	2996	448	77	59	12	443	459
Supply and Place 50 mm HL-3 Asphalt in Boulevards	4575	366	92	1114	167	95	73	15	549	488
Supply and Place $CaCl_2$ for Dust Control	200	16	4	17	3	1	1	0	8	0
Supply and Place Subdrains	1845	148	37	610	91	41	31	6	235	0
Relocation of Utilities, Miscellaneous	15612	3122	781	3396	507	507	390	78	2927	0
Engineering Design	6654	1863	466	3763	562	0	0	0	0	0
Engineering Construction Management	5822	1630	408	3292	492	0	0	0	0	0
Column Total	95645	12020	3005	24506	3662	1829	1407	281	10552	10806
	1	2	3	4	5	6	7	8	9	10

SUP A4 (continued)	Non-Met. Mineral Products	Petroleum & Coal Products	Tax	Primary Metal Products	Chemicals Chemical Products	Electrical & Comm Products	Plastic Fabricated Products	Trans-port	Total
Excavate Existing Road Base; Grade and Shape Subbase	0	0	0	0	0	0	0	0	5363
Granular "A" Base 600 mm Depth	0	0	0	0	0	0	0	2601	11475
Additional Excavation for Soft Subgrade	0	0	0	0	0	0	0	0	720
Granular Backfill for Soft Spot Excavation	0	0	0	0	0	0	0	239	1560
Burn and Plane Asphalt 25 mm by 600 mm	0	0	0	0	0	0	0	0	200
Adjust Manholes, Catchbasins, Valve Chambers	298	0	0	0	0	0	0	0	850
Clean Manholes	0	0	0	0	0	0	0	0	400
Supply and Place 120 mm HL-5 Binder Asphalt	0	2930	533	0	0	0	0	1509	11925
Supply and Place 40 mm HL-3 Surface Asphalt	0	1774	279	0	0	0	0	495	5280
Construct Single Catchbasin	578	0	0	612	0	0	0	11	1700
Construct Double Catchbasin	858	0	0	1066	0	0	0	9	2600
Construct 250 mm Curb Drains	429	0	0	0	0	0	0	65	3900
Construct Curb and Gutter	1960	0	163	0	0	0	0	490	5125
Construct Sidewalk 1.5 m Wide	3100	0	258	0	0	0	0	1005	9840
Supply and Place 50 mm HL-3 Asphalt in Boulevards	0	1373	0	0	0	0	0	244	4575
Supply and Place $CaCl_2$ for Dust Control	0	0	0	0	150	0	0	0	200
Supply and Place Subdrains	0	0	0	0	0	0	646	0	1845
Relocation of Utilities, Miscellaneous	585	0	49	312	0	2342	468	146	15612
Engineering Design	0	0	0	0	0	0	0	0	6654
Engineering Construction Management	0	0	0	0	0	0	0	0	5822
Column Total	7808	6076	1282	1990	150	2342	1114	6814	95645
	11	12	13	14	15	16	17	18	19

Standard Unit Project A5 Two-Lane Rural Road Reconstruction	Total	Administration		Labour			Equipment			Non-Met. Minerals
		Overhead	Profit	Wages	Fringe	Fuel	Repairs	Insurance	Depreci-ation	
task										
Excavation for Widening, Deficiencies	780	62	16	115	17	74	57	11	427	0
Granular "A"	2015	161	40	263	39	76	58	12	438	618
Ditching	2400	192	48	355	53	228	175	35	1314	0
Supply and Lay Cold-Mix Surface Course	3185	255	64	360	54	41	32	6	239	597
Surface Treatment	900	72	18	102	15	12	9	2	68	169
Granular "A" in Shoulders	520	42	10	68	10	20	15	3	113	159
Relocations, Miscellaneous	980	196	49	213	32	32	25	5	184	33
Engineering Design	539	151	38	305	46	0	0	0	0	0
Engineering Construction Management	539	151	38	305	46	0	0	0	0	0
Column Total	11858	1282	320	2086	312	482	371	74	2783	1576
	1	2	3	4	5	6	7	8	9	10

SUP A5 (continued)	Non-Met. Mineral Products	Petroleum & Coal Products	Tax	Primary Metal Products	Chemicals Chemical Products	Electrical & Comm Products	Metal Fabricated Products	Trans-port	Total
Excavation for Widening, Deficiencies	0	0	0	0	0	0	0	0	780
Granular "A"	0	0	0	0	0	0	0	309	2015
Ditching	0	0	0	0	0	0	0	0	2400
Supply and Lay Cold-Mix Surface Course	0	1070	168	0	0	0	0	299	3185
Surface Treatment	0	302	48	0	0	0	0	84	900
Granular "A" in Shoulders	0	0	0	0	0	0	0	80	520
Relocations, Miscellaneous	0	0	0	147	0	0	49	16	980
Engineering Design	0	0	0	0	0	0	0	0	539
Engineering Construction Management	0	0	0	0	0	0	0	0	539
Column Total	0	1373	216	147	0	0	49	788	11858
	11	12	13	14	15	16	17	18	19

Standard Unit Project A6 Two-Lane Urban Road Reconstruction	Total	Administration		Labour		Equipment				Non-Met. Minerals
		Overhead	Profit	Wages	Fringe	Fuel	Repairs	Insurance	Depreci-ation	
task										
Earth Excavation	6020	482	120	2252	337	368	283	57	2122	0
Granular "A" (450 mm)	9450	756	189	987	147	123	95	19	709	4284
Hot-Mix HL-8 (80 mm)	7650	612	153	865	129	99	77	15	574	1595
Hot-Mix HL-3 (40 mm)	4080	326	82	461	69	53	41	8	306	765
Concrete Curb and Gutter	5250	420	105	1233	184	82	63	13	473	0
Hot-Mix HL-3 Fine in Driveways	990	79	20	241	36	21	16	3	119	106
$CaCl_2$	460	37	9	40	6	3	2	0	17	0
Adjust Existing Manholes	1335	107	27	441	66	0	0	0	0	0
Water for Compaction	250	20	5	98	15	15	11	2	84	0
Relocation of Utilities, Miscellaneous	3549	710	177	772	115	115	89	18	665	0
Engineering Design	3123	874	219	1766	264	0	0	0	0	0
Engineering Construction Management	2732	765	191	1545	231	0	0	0	0	0
Column Total	44889	5188	1297	10702	1599	879	676	135	5069	6749
	1	2	3	4	5	6	7	8	9	10

SUP A6 (continued)	Non-Met. Mineral Products	Petroleum & Coal Products	Tax	Primary Metal Products	Chemicals Chemical Products	Electrical & Comm Products	Plastic Fabricated Products	Trans-port	Total
Earth Excavation	0	0	0	0	0	0	0	0	6020
Granular "A" (450 mm)	0	0	0	0	0	0	0	2142	9450
Hot-Mix HL-8 (80 mm)	0	2392	342	0	0	0	0	797	7650
Hot-Mix HL-3 (40 mm)	0	1371	215	0	0	0	0	382	4080
Concrete Curb and Gutter	2008	0	167	0	0	0	0	502	5250
Hot-Mix HL-3 Fine in Driveways	0	297	0	0	0	0	0	53	990
$CaCl_2$	0	0	0	0	345	0	0	0	460
Adjust Existing Manholes	93	0	0	501	0	0	0	0	1335
Water for Compaction	0	0	0	0	0	0	0	0	250
Relocation of Utilities, Miscellaneous	133	0	11	71	0	532	106	33	3549
Engineering Design	0	0	0	0	0	0	0	0	3123
Engineering Construction Management	0	0	0	0	0	0	0	0	2732
Column Total	2235	4060	736	672	345	532	106	3910	44889
	11	12	13	14	15	16	17	18	19

Standard Unit Project A7 Three-Span Bridge Rehabilitation	Total	Administration		Labour			Equipment			Non-Met. Minerals	Non-Met. Mineral Products
		Overhead	Profit	Wages	Fringe	Fuel	Repairs	Insurance	Depreciation		
task											
Traffic Control	2000	160	40	1044	156	26	20	4	150	0	0
Removal of Concrete in Deck and Walls	16200	1296	324	11275	1685	211	162	32	1215	0	0
Concrete in Ballast Walls and Blockouts	3000	240	60	1697	254	39	30	6	225	300	0
Place Latex-Modified Concrete Overlay	19600	1568	392	4263	637	255	196	39	1470	0	0
Finish Texture and Cure Overlay	6000	480	120	4176	624	78	60	12	450	0	0
Supply and Install Joint Assemblies	19000	1520	380	3306	494	124	95	19	713	0	0
Steel Beam Guide Rail on Approaches	8800	704	176	2297	343	229	176	35	1320	0	0
Cleaning, Painting Steel Piles in Pier Bents	4000	320	80	2784	416	26	20	4	150	0	0
Sandblasting Deck	2000	160	40	1044	156	52	40	8	300	133	0
Scarifying Deck	2808	225	56	1466	219	110	84	17	632	0	0
Excavation and Backfill for Ballast Wall	4000	320	80	696	104	364	280	56	2100	0	0
Hot-Mix HL-3	2800	224	56	317	47	36	28	6	210	1069	0
Dowels in Concrete Ballast Walls	510	41	10	266	40	17	13	3	96	0	0
Remove Existing Railing & Posts	2000	160	40	1044	156	78	60	12	450	0	0
Concrete in Barrier Walls	12000	960	240	4176	624	234	180	36	1350	0	3150
Steel Rail for Barrier Wall	3000	240	60	653	98	39	30	6	225	0	0
Dowels into Concrete Curb	7920	634	158	4134	618	257	198	40	1485	0	0
Coated Reinforced Steel	4000	320	80	696	104	0	0	0	0	0	0
Engineering Design	9571	2680	670	5412	809	0	0	0	0	0	0
Construction Supervision	8375	2345	586	4736	708	0	0	0	0	0	0
Column Total	137584	14596	3649	55481	8290	2174	1672	334	12540	1503	3150
	1	2	3	4	5	6	7	8	9	10	11

SUP A7 (continued)	Petroleum & Coal Products	Tax	Primary Metal Products	Chemicals Chemical Products	Electrical & Comm Products	Plastic Fabricated Products	Trans-port	Metal Fabricated Products	Lumber, Wood Products	Margin
Traffic Control	0	0	0	0	0	400	0	0	0	2000
Removal of Concrete in Deck and Walls	0	0	0	0	0	0	0	0	0	16200
Concrete in Ballast Walls and Blockouts	0	0	0	0	0	0	150	0	0	3000
Place Latex-Modified Concrete Overlay	0	0	0	0	0	10780	0	0	0	19600
Finish Texture and Cure Overlay	0	0	0	0	0	0	0	0	0	6000
Supply and Install Joint Assemblies	0	0	0	0	0	0	0	12350	0	19000
Steel Beam Guide Rail on Approaches	0	0	0	200	0	0	0	3520	0	8800
Cleaning, Painting Steel Piles in Pier Bents	0	0	0	0	0	0	0	0	0	4000
Sandblasting Deck	0	0	0	0	0	0	67	0	0	2000
Scarifying Deck	0	0	0	0	0	0	0	0	0	2808
Excavation and Backfill for Ballast Wall	0	0	0	0	0	0	0	0	0	4000
Hot-Mix HL-3	694	113	0	0	0	0	0	0	0	2800
Dowels in Concrete Ballast Walls	0	0	26	0	0	0	0	0	0	510
Remove Existing Railing & Posts	0	0	0	0	0	0	0	0	0	2000
Concrete in Barrier Walls	0	0	0	0	0	0	0	0	1050	12000
Steel Rail for Barrier Wall	0	0	0	0	0	0	0	1650	0	3000
Dowels into Concrete Curb	0	0	396	0	0	0	0	0	0	7920
Coated Reinforced Steel	0	0	2800	0	0	0	0	0	0	4000
Engineering Design	0	0	0	0	0	0	0	0	0	9571
Construction Supervision	0	0	0	0	0	0	0	0	0	8375
Column Total	694	113	3222	200	0	11180	217	17520	1050	137584
	12	13	14	15	16	17	18	19	20	21

Standard Unit Project A8 Short-Span Bridge Construction (Over Land)	Total	Administration		Labour			Equipment			Non-Met. Minerals	Non-Met. Mineral Products
		Overhead	Profit	Wages	Fringe	Fuel	Repairs	Insurance	Depreci-ation		
task											
Clearing and Grubbing	1768	141	35	615	92	115	88	18	663	0	0
Earth Excavation	2184	175	44	817	122	133	103	21	770	0	0
Earth Borrow	936	75	19	350	52	57	44	9	330	0	0
Granular "A"	2839	227	57	296	44	37	28	6	213	1287	0
Granular "B"	5853	468	117	611	91	76	59	12	439	2653	0
Steel Beam Guide Rail	5533	443	111	1444	216	144	111	22	830	0	0
Topsoil, Seeding	1820	146	36	238	35	95	73	15	546	0	0
Replacement Gravel	1248	100	25	163	24	32	25	5	187	458	0
RIP-RAP	1685	135	34	440	66	33	25	5	190	505	0
Removal of Existing Bridge	2600	208	52	452	68	237	182	36	1365	0	0
Earth Excavation for Structure	1040	83	21	317	47	74	57	11	429	0	0
Rock Excavation for Structure	5460	437	109	2138	319	246	191	38	1433	0	0
Granular "B" Backfill for Structure	5918	473	118	1287	192	115	89	18	666	1973	0
Dowels into Rock	624	50	12	326	49	20	16	3	117	0	0
Reinforcing Steel	8866	709	177	3085	461	0	0	0	0	0	0
Coated Reinforced Steel	10816	865	216	1882	281	0	0	0	0	0	0
Concrete in Foundations	19500	1560	390	4241	634	507	390	78	2925	0	7020
Concrete in Abutments and Wingwalls	57200	4576	1144	17417	2603	1115	858	172	6435	0	17160
Concrete in Deck and Diaphragms	24596	1968	492	7489	1119	799	615	123	4612	0	6272
Concrete in Parapet Walls	14560	1165	291	5067	757	284	218	44	1638	0	3822
Prestressed Concrete Girder	41808	3345	836	5456	815	544	418	84	3136	0	27175
Install Expansion Joint Assemblies	15600	1248	312	2714	406	101	78	16	585	0	0
Steel Barrier Rail	2080	166	42	452	68	27	21	4	156	0	0
Precast Concrete Retaining Wall	10400	832	208	2262	338	270	208	42	1560	0	4680
Place Telephone Ducts	520	42	10	271	41	0	0	0	0	0	0
Engineering Design	19636	5498	1375	11104	1659	0	0	0	0	0	0
Construction Supervision	17182	4811	1203	9716	1452	0	0	0	0	0	0
Column Total	282272	29945	7486	80653	12052	5065	3896	779	29224	6876	66129
	1	2	3	4	5	6	7	8	9	10	11

SUP A8 (continued)	Petroleum & Coal Products	Tax	Primary Metal Products	Chemicals Chemical Products	Electrical & Comm Products	Plastic Fabricated Products	Trans-port	Metal Fabricated Products	Lumber, Wood Products	Agric. & Forestry Products	Total
Clearing and Grubbing	0	0	0	0	0	0	0	0	0	0	1768
Earth Excavation	0	0	0	0	0	0	0	0	0	0	2184
Earth Borrow	0	0	0	0	0	0	0	0	0	0	936
Granular "A"	0	0	0	0	0	0	644	0	0	0	2839
Granular "B"	0	0	0	0	0	0	1327	0	0	0	5853
Steel Beam Guide Rail	0	0	0	0	0	0	0	2213	0	0	5533
Topsoil, Seeding	0	0	0	0	0	0	0	0	0	637	1820
Replacement Gravel	0	0	0	0	0	0	229	0	0	0	1248
RIP-RAP	0	0	0	0	0	0	253	0	0	0	1685
Removal of Existing Bridge	0	0	0	0	0	0	0	0	0	0	2600
Earth Excavation for Structure	0	0	0	0	0	0	0	0	0	0	1040
Rock Excavation for Structure	0	0	0	546	0	0	0	0	0	0	5460
Granular "B" Backfill for Structure	0	0	0	0	0	0	988	0	0	0	5918
Dowels into Rock	0	0	31	0	0	0	0	0	0	0	624
Reinforcing Steel	0	0	4433	0	0	0	0	0	0	0	8866
Coated Reinforced Steel	0	0	7571	0	0	0	0	0	0	0	10816
Concrete in Foundations	0	0	0	0	0	0	0	0	1755	0	19500
Concrete in Abutments and Wingwalls	0	0	0	0	0	0	0	0	5720	0	57200
Concrete in Deck and Diaphragms	0	0	0	0	0	0	0	0	1107	0	24596
Concrete in Parapet Walls	0	0	0	0	0	0	0	0	1274	0	14560
Prestressed Concrete Girder	0	0	0	0	0	0	0	0	0	0	41808
Install Expansion Joint Assemblies	0	0	0	0	0	0	0	10140	0	0	15600
Steel Barrier Rail	0	0	0	0	0	0	0	1144	0	0	2080
Precast Concrete Retaining Wall	0	0	0	0	0	0	0	0	0	0	10400
Place Telephone Ducts	0	0	0	0	0	156	0	0	0	0	520
Engineering Design	0	0	0	0	0	0	0	0	0	0	19636
Construction Supervision	0	0	0	0	0	0	0	0	0	0	17182
Column Total	0	0	12035	546	0	156	3438	13497	9856	637	282272
	12	13	14	15	16	17	18	19	20	21	22

Standard Unit Project A9 Short-Span Bridge Construction (Over Water)	Total	Administration		Labour		Fuel	Equipment			Non-Met. Minerals	Non-Met. Mineral Products
		Overhead	Profit	Wages	Fringe		Repairs	Insurance	Depreci-ation		
task											
Clearing and Grubbing	1768	141	35	615	92	115	88	18	663	0	0
Earth Excavation	2184	175	44	817	122	133	103	21	770	0	0
Earth Borrow	936	75	19	350	52	57	44	9	330	0	0
Granular "A"	2839	227	57	296	44	37	28	6	213	1287	0
Granular "B"	5853	468	117	611	91	76	59	12	439	2653	0
Steel Beam Guide Rail	5533	443	111	1444	216	144	111	22	830	0	0
Topsoil, Seeding	1820	146	36	238	35	95	73	15	546	0	0
Replacement Gravel	1248	100	25	163	24	32	25	5	187	458	0
RIP-RAP	1685	135	34	440	66	33	25	5	190	505	0
Removal of Existing Bridge	2600	208	52	452	68	237	182	36	1365	0	0
Unwatering	23400	1872	468	5090	761	1065	819	164	6143	0	0
Earth Excavation for Structure	1040	83	21	317	47	74	57	11	429	0	0
Rock Excavation for Structure	5460	437	109	2138	319	248	191	38	1433	0	0
Granular "B" Backfill for Structure	5918	473	118	1287	192	115	89	18	666	1973	0
Dowels into Rock	624	50	12	326	49	20	16	3	117	0	0
Reinforcing Steel	8866	709	177	3085	461	0	0	0	0	0	0
Coated Reinforced Steel	10816	865	216	1882	281	0	0	0	0	0	0
Concrete in Foundations	19500	1560	390	4241	634	507	390	78	2925	0	7020
Concrete in Abutments and Wingwalls	57200	4576	1144	17417	2603	1115	858	172	6435	0	17160
Concrete in Deck and Diaphragms	24596	1968	492	7489	1119	799	615	123	4612	0	6272
Concrete in Parapet Walls	14560	1165	291	5067	757	284	218	44	1638	0	3822
Prestressed Concrete Girder	41808	3345	836	5456	815	544	418	84	3136	0	27175
Install Expansion Joint Assemblies	15600	1248	312	2714	406	101	78	16	585	0	0
Steel Barrier Rail	2080	166	42	452	68	27	21	4	156	0	0
Precast Concrete Retaining Wall	10400	832	208	2262	338	270	208	42	1560	0	4680
Place Telephone Ducts	520	42	10	271	41	0	0	0	0	0	0
Engineering Design	21508	6022	1506	12163	1817	0	0	0	0	0	0
Construction Supervision	18820	5270	1317	10643	1590	0	0	0	0	0	0
Column Total	309182	32800	8200	87727	13109	6130	4715	943	35366	6876	66129
	1	2	3	4	5	6	7	8	9	10	11

SUP A9 (continued)	Petroleum & Coal Products	Tax	Primary Metal Products	Chemicals Chemical Products	Electrical & Comm Products	Plastic Fabricated Products	Trans-port	Metal Fabricated Products	Lumber, Wood Products	Agric. & Forestry Products	Total
Clearing and Grubbing	0	0	0	0	0	0	0	0	0	0	1768
Earth Excavation	0	0	0	0	0	0	0	0	0	0	2184
Earth Borrow	0	0	0	0	0	0	0	0	0	0	936
Granular "A"	0	0	0	0	0	0	544	0	0	0	2839
Granular "B"	0	0	0	0	0	0	1327	0	0	0	5853
Steel Beam Guide Rail	0	0	0	0	0	0	0	2213	0	0	5533
Topsoil, Seeding	0	0	0	0	0	0	0	0	0	637	1820
Replacement Gravel	0	0	0	0	0	0	229	0	0	0	1248
RIP-RAP	0	0	0	0	0	0	253	0	0	0	1685
Removal of Existing Bridge	0	0	0	0	0	0	0	0	0	0	2600
Unwatering	0	0	0	0	0	0	0	7020	0	0	23400
Earth Excavation for Structure	0	0	0	0	0	0	0	0	0	0	1040
Rock Excavation for Structure	0	0	0	546	0	0	0	0	0	0	5460
Granular "B" Backfill for Structure	0	0	0	0	0	0	986	0	0	0	5918
Dowels into Rock	0	0	31	0	0	0	0	0	0	0	624
Reinforcing Steel	0	0	4433	0	0	0	0	0	0	0	8866
Coated Reinforced Steel	0	0	7571	0	0	0	0	0	0	0	10816
Concrete in Foundations	0	0	0	0	0	0	0	0	1755	0	19500
Concrete in Abutments and Wingwalls	0	0	0	0	0	0	0	0	5720	0	57200
Concrete in Deck and Diaphragms	0	0	0	0	0	0	0	0	1107	0	24596
Concrete in Parapet Walls	0	0	0	0	0	0	0	0	1274	0	14560
Prestressed Concrete Girder	0	0	0	0	0	0	0	0	0	0	41808
Install Expansion Joint Assemblies	0	0	0	0	0	0	0	10140	0	0	15600
Steel Barrier Rail	0	0	0	0	0	0	0	1144	0	0	2080
Precast Concrete Retaining Wall	0	0	0	0	0	0	0	0	0	0	10400
Place Telephone Ducts	0	0	0	0	0	156	0	0	0	0	520
Engineering Design	0	0	0	0	0	0	0	0	0	0	21508
Construction Supervision	0	0	0	0	0	0	0	0	0	0	18820
Column Total	0	0	12035	546	0	156	3438	20517	9856	637	309182
	12	13	14	15	16	17	18	19	20	21	22

Standard Unit Project A10 Medium-Span Bridge Construction (Over Land)	Total	Administration		Labour			Equipment			Non-Met. Minerals	Non-Met. Mineral Products
		Overhead	Profit	Wages	Fringe	Fuel	Repairs	Insurance	Depreci-ation		
task											
Clearing and Grubbing	4680	374	94	1629	243	304	234	47	1755	0	0
Earth Excavation for Foundations	28267	2261	565	10575	1580	1727	1329	266	9964	0	0
Rock Excavation for Foundations	8954	716	179	3506	524	407	313	63	2351	0	0
Supply Pile Driving Equipment	9360	749	187	3868	578	517	398	80	2984	0	0
Supply and Drive "H" Piles	47851	3828	957	6245	933	0	0	0	0	0	0
Rock Anchors	58968	4717	1179	20521	3066	1533	1179	236	8845	0	0
Dowels into Rock	1404	112	28	733	110	46	35	7	263	0	0
Granular "B" for Structure	30888	2471	618	3225	482	402	309	62	2317	14003	0
Reinforcing Steel	75920	6074	1518	26420	3948	0	0	0	0	0	0
Coated Reinforced Steel	44616	3569	892	7763	1160	0	0	0	0	0	0
Concrete in Foundations	78858	6309	1577	17152	2563	2050	1577	315	11829	0	28389
Concrete in Abutments and Wingwalls	81120	6490	1622	24701	3691	1582	1217	243	9126	0	24336
Concrete in Piers	40040	3203	801	15676	2342	781	601	120	4505	0	8408
Concrete in Retaining Walls	40950	3276	819	8907	1331	1065	819	164	6143	0	13821
Concrete in Decks and Diaphragms	211120	16890	4222	64286	9606	4117	3167	633	23751	0	63336
Deck Drains	1872	150	37	489	73	0	0	0	0	0	0
Concrete in Barrier Walls	51480	4118	1030	17915	2677	1004	772	154	5792	0	13514
Concrete in Approach Slabs	7020	562	140	1527	228	91	70	14	527	0	3861
Prestressed Concrete Girders	240240	19219	4805	31351	4685	3123	2402	480	18018	0	156156
Install Expansion Joint Assemblies	17160	1373	343	2986	446	112	86	17	644	0	0
Steel Parapet Rail	10530	842	211	2290	342	137	105	21	790	0	0
Asphalt Membrane Waterproofing	16640	1331	333	4343	649	108	83	17	624	0	0
HL-6	14976	1198	300	1694	253	195	150	30	1123	5719	0
RIP-RAP	4680	374	94	1221	183	91	70	14	527	1404	0
Rock Protection	8320	666	166	2172	324	324	250	50	1872	1664	0
Engineering Design	90873	25444	6361	51389	7679	0	0	0	0	0	0
Construction Supervision	79514	22264	5566	44965	6719	0	0	0	0	0	0
Column Total	1306302	138582	34645	377546	56415	19716	15166	3033	113746	22790	311820
	1	2	3	4	5	6	7	8	9	10	11

SUP A10 (continued)	Petroleum & Coal Products	Tax	Primary Metal Products	Chemicals Chemical Products	Electrical & Comm Products	Plastic Fabricated Products	Trans-port	Metal Fabricated Products	Lumber, Wood Products	Total
Clearing and Grubbing	0	0	0	0	0	0	0	0	0	4680
Earth Excavation for Foundations	0	0	0	0	0	0	0	0	0	28267
Rock Excavation for Foundations	0	0	0	895	0	0	0	0	0	8954
Supply Pile Driving Equipment	0	0	0	0	0	0	0	0	0	9360
Supply and Drive "H" Piles	0	0	0	0	0	0	0	35889	0	47851
Rock Anchors	0	0	17690	0	0	0	0	0	0	58968
Dowels into Rock	0	0	70	0	0	0	0	0	0	1404
Granular "B" for Structure	0	0	0	0	0	0	7001	0	0	30888
Reinforcing Steel	0	0	37960	0	0	0	0	0	0	75920
Coated Reinforced Steel	0	0	31231	0	0	0	0	0	0	44616
Concrete in Foundations	0	0	0	0	0	0	0	0	7097	78858
Concrete in Abutments and Wingwalls	0	0	0	0	0	0	0	0	8112	81120
Concrete in Piers	0	0	0	0	0	0	0	0	3604	40040
Concrete in Retaining Walls	0	0	0	0	0	0	0	0	4607	40950
Concrete in Decks and Diaphragms	0	0	0	0	0	0	0	0	21112	211120
Deck Drains	0	0	0	0	0	0	0	1123	0	1872
Concrete in Barrier Walls	0	0	0	0	0	0	0	0	4505	51480
Concrete in Approach Slabs	0	0	0	0	0	0	0	0	0	7020
Prestressed Concrete Girders	0	0	0	0	0	0	0	0	0	240240
Install Expansion Joint Assemblies	0	0	0	0	0	0	0	11154	0	17160
Steel Parapet Rail	0	0	0	0	0	0	0	5792	0	10530
Asphalt Membrane Waterproofing	0	0	0	9152	0	0	0	0	0	16640
HL-6	3713	602	0	0	0	0	0	0	0	14976
RIP-RAP	0	0	0	0	0	0	702	0	0	4680
Rock Protection	0	0	0	0	0	0	832	0	0	8320
Engineering Design	0	0	0	0	0	0	0	0	0	90873
Construction Supervision	0	0	0	0	0	0	0	0	0	79514
Column Total	3713	602	86952	10047	0	0	8535	53957	49036	1306302
	12	13	14	15	16	17	18	19	20	21

Standard Unit Project A11 Medium-Span Bridge Construction (Over Water)	Total	Administration		Labour		Equipment				Non-Met. Minerals	Non-Met. Mineral Products
		Overhead	Profit	Wages	Fringe	Fuel	Repairs	Insurance	Depreciation		
task											
Clearing and Grubbing	4680	374	94	1629	243	304	234	47	1755	0	0
Earth Excavation for Foundations	28267	2261	565	10575	1580	1727	1329	266	9964	0	0
Rock Excavation for Foundations	8954	716	179	3506	524	407	313	63	2351	0	0
Unwatering	134160	10733	2683	29160	4360	6104	4696	939	35217	0	0
Supply Pile Driving Equipment	9360	749	187	3868	578	517	398	80	2984	0	0
Supply and Drive "H" Piles	47851	3828	957	6245	933	0	0	0	0	0	0
Rock Anchors	58968	4717	1179	20521	3066	1533	1179	236	8845	0	0
Dowels into Rock	1404	112	28	733	110	46	35	7	263	0	0
Granular "B" for Structure	30688	2471	618	3225	482	402	309	62	2317	14003	0
Reinforcing Steel	75920	6074	1518	26420	3948	0	0	0	0	0	0
Coated Reinforced Steel	44616	3569	892	7763	1160	0	0	0	0	0	0
Concrete in Foundations	78858	6309	1577	17152	2563	2050	1577	315	11829	0	28389
Concrete in Abutments and Wingwalls	81120	6490	1622	24701	3691	1582	1217	243	9126	0	24336
Concrete in Piers	40040	3203	801	15676	2342	781	601	120	4505	0	8408
Concrete in Retaining Walls	40950	3276	819	8907	1331	1065	819	164	6143	0	13821
Concrete in Decks and Diaphragms	211120	16890	4222	64286	9606	4117	3167	633	23751	0	63336
Deck Drains	1872	150	37	489	73	0	0	0	0	0	0
Concrete in Barrier Walls	51480	4118	1030	17915	2677	1004	772	154	5792	0	13514
Concrete in Approach Slabs	7020	562	140	1527	228	91	70	14	527	0	3861
Prestressed Concrete Girders	240240	19219	4805	31351	4685	3123	2402	480	18018	0	156156
Install Expansion Joint Assemblies	17160	1373	343	2986	446	112	86	17	644	0	0
Steel Parapet Rail	10530	842	211	2290	342	137	105	21	790	0	0
Asphalt Membrane Waterproofing	16640	1331	333	4343	649	108	83	17	624	0	0
HL-6	14976	1198	300	1694	253	195	150	30	1123	5719	0
RIP-RAP	4680	374	94	1221	183	91	70	14	527	1404	0
Rock Protection	8320	666	166	2172	324	324	250	50	1872	1664	0
Engineering Design	101606	28450	7112	57458	8586	0	0	0	0	0	0
Construction Supervision	88905	24893	6223	50276	7512	0	0	0	0	0	0
Column Total	1460586	154949	38737	418106	62476	25820	19862	3972	148963	22790	311820
	1	2	3	4	5	6	7	8	9	10	11

SUP A11 (continued)	Petroleum & Coal Products	Tax	Primary Metal Products	Chemicals Chemical Products	Electrical & Comm Products	Plastic Fabricated Products	Trans-port	Metal Fabricated Products	Lumber, Wood Products	Total
Clearing and Grubbing	0	0	0	0	0	0	0	0	0	4680
Earth Excavation for Foundations	0	0	0	0	0	0	0	0	0	28267
Rock Excavation for Foundations	0	0	0	895	0	0	0	0	0	8954
Unwatering	0	0	0	0	0	0	0	40248	0	134160
Supply Pile Driving Equipment	0	0	0	0	0	0	0	0	0	9360
Supply and Drive "H" Piles	0	0	0	0	0	0	0	35889	0	47851
Rock Anchors	0	0	17690	0	0	0	0	0	0	58968
Dowels into Rock	0	0	70	0	0	0	0	0	0	1404
Granular "B" for Structure	0	0	0	0	0	0	7001	0	0	30888
Reinforcing Steel	0	0	37960	0	0	0	0	0	0	75920
Coated Reinforced Steel	0	0	31231	0	0	0	0	0	0	44616
Concrete in Foundations	0	0	0	0	0	0	0	0	7097	78858
Concrete in Abutments and Wingwalls	0	0	0	0	0	0	0	0	8112	81120
Concrete in Piers	0	0	0	0	0	0	0	0	3604	40040
Concrete in Retaining Walls	0	0	0	0	0	0	0	0	4607	40950
Concrete in Decks and Diaphragms	0	0	0	0	0	0	0	0	21112	211120
Deck Drains	0	0	0	0	0	0	0	1123	0	1872
Concrete in Barrier Walls	0	0	0	0	0	0	0	0	4505	51480
Concrete in Approach Slabs	0	0	0	0	0	0	0	0	0	7020
Prestressed Concrete Girders	0	0	0	0	0	0	0	0	0	240240
Install Expansion Joint Assemblies	0	0	0	0	0	0	0	11154	0	17160
Steel Parapet Rail	0	0	0	0	0	0	0	5792	0	10530
Asphalt Membrane Waterproofing	0	0	0	9152	0	0	0	0	0	16640
HL-6	3713	602	0	0	0	0	0	0	0	14976
RIP-RAP	0	0	0	0	0	0	702	0	0	4680
Rock Protection	0	0	0	0	0	0	832	0	0	8320
Engineering Design	0	0	0	0	0	0	0	0	0	101606
Construction Supervision	0	0	0	0	0	0	0	0	0	88905
Column Total	3713	602	86952	10047	0	0	8535	94205	49036	1460586
	12	13	14	15	16	17	18	19	20	21

Standard Unit Project B1 Major Upgrade of a 2000 ft Runway	Total	Administration		Labour			Equipment			Non-Met. Minerals	Non-Met. Mineral Products
		Overhead	Profit	Wages	Fringe	Fuel	Repairs	Insurance	Depreci-ation		
task											
Tree Planting	12192	975	244	3182	475	158	122	24	914	0	0
Clearing	23470	1878	469	8167	1220	1526	1173	235	8801	0	0
Clearing and Grubbing	14173	1134	283	4932	737	921	709	142	5315	0	0
Earth Excavation	45647	3652	913	17076	2552	2789	2145	429	16091	0	0
Select Subgrade Mix	152156	12172	3043	19856	2967	5736	4413	883	33094	46661	0
Hot-Mix Asphalt	193048	15444	3861	21834	3263	2510	1930	386	14479	66631	0
Granular "A"	59951	4796	1199	6259	935	779	600	120	4496	27178	0
Granular "B"	99548	7964	1991	10393	1553	1294	995	199	7466	45128	0
Cutting Existing Pavement	7242	579	145	3780	565	282	217	43	1629	0	0
150 mm Subdrains	39228	3138	786	12969	1938	867	667	133	5002	0	0
Pumping Station	20000	1600	400	3480	520	260	200	40	1500	0	4200
Culverts	19020	1522	380	7281	1088	742	571	114	4279	304	0
Water for Compaction	8420	674	168	3297	493	493	379	76	2842	0	0
Removal of Asphalt	5005	400	100	1306	195	390	300	60	2252	0	0
Removal of Fence	695	56	14	363	54	27	21	4	156	0	0
Farm Fencing or Posts	5944	475	119	1551	232	155	119	24	892	0	0
Chain Link Security Fence	7925	634	158	2068	309	206	158	32	1189	0	0
Sodding	1843	147	37	802	120	24	18	4	138	0	0
Seeding and Mulching	45825	3666	917	5980	894	2383	1833	367	13748	0	0
Pavement Markings	1119	89	22	292	44	73	56	11	419	0	0
Trenching for Electrical Wiring	9272	742	185	4840	723	362	278	56	2086	0	0
Concrete Duct Banks	2664	213	53	695	104	35	27	5	200	0	1066
Cable for Runway Lights	9637	771	193	2515	376	0	0	0	0	0	0
Cable for VASIS/PAPI	2130	170	43	556	83	0	0	0	0	0	0
Cable for RILS	4367	349	87	1140	170	0	0	0	0	0	0
Cable for Windsock	3840	307	77	1002	150	0	0	0	0	0	0
Counterpoise for Wiring	2223	178	44	580	87	0	0	0	0	0	0
Runway Edge Lights	10961	877	219	2861	427	214	164	33	1233	0	0
Runway Threshold Lights	4145	332	83	1082	162	81	62	12	466	0	0
Taxiway Lights	4645	372	93	1212	181	91	70	14	523	0	0
Apron Edge Lights	0	0	0	0	0	0	0	0	0	0	0
VASIS/PAPI	26350	2108	527	4585	685	343	263	53	1976	0	0
RILS	14780	1182	296	2572	384	192	148	30	1108	0	0
Illuminated Windcone	10400	832	208	1810	270	135	104	21	780	0	0
Regulator for Lights	21500	1720	430	3741	559	140	108	22	806	0	0
Regulator for VASIS/PAPI	24000	1920	480	4176	624	156	120	24	900	0	0
Visual Aids Control System	10000	800	200	1740	260	65	50	10	375	0	0
Meterological Equipment	7500	600	150	1305	195	49	38	8	281	0	0
Refurbish Air Terminal Building	12000	960	240	3132	468	312	240	48	1800	0	2400
Field Electrical Centre	16000	1280	320	2784	416	208	160	32	1200	0	960
New Fuel Tanks	45000	3600	900	7830	1170	1170	900	180	6750	0	0
External Power Services	60000	4800	1200	10440	1560	390	300	60	2250	0	0
Miscellaneous	48560	9712	2428	10562	1578	1578	1214	243	9105	0	0
Engineering Design	111243	31148	7787	62908	9400	0	0	0	0	0	0
Engineering Construction Management	88994	24918	6230	50326	7520	0	0	0	0	0	0
Column Total	1312662	150888	37722	319263	47706	27134	20872	4174	156543	185903	8626
	1	2	3	4	5	6	7	8	9	10	11

SUP B1 (continued)

	Petroleum & Coal Products	Tax	Primary Metal Products	Chemicals Chemical Products	Electrical & Comm Products	Plastic Fabricated Products	Trans-port	Metal Fabricated Products	Lumber, Wood Products	Agric. & Forestry Products	Total
Tree Planting	0	0	0	0	0	0	0	0	0	6096	12192
Clearing	0	0	0	0	0	0	0	0	0	0	23470
Clearing and Grubbing	0	0	0	0	0	0	0	0	0	0	14173
Earth Excavation	0	0	0	0	0	0	0	0	0	0	45647
Select Subgrade Mix	0	0	0	0	0	0	23331	0	0	0	152156
Hot-Mix Asphalt	54872	7839	0	0	0	0	0	0	0	0	193048
Granular "A"	0	0	0	0	0	0	13589	0	0	0	59951
Granular "B"	0	0	0	0	0	0	22564	0	0	0	99548
Cutting Existing Pavement	0	0	0	0	0	0	0	0	0	0	7242
150 mm Subdrains	0	0	0	0	0	13730	0	0	0	0	39228
Pumping Station	0	0	2400	0	5400	0	0	0	0	0	20000
Culverts	0	0	0	0	0	0	152	2587	0	0	19020
Water for Compaction	0	0	0	0	0	0	0	0	0	0	8420
Removal of Asphalt	0	0	0	0	0	0	0	0	0	0	5005
Removal of Fence	0	0	0	0	0	0	0	0	0	0	695
Farm Fencing or Posts	0	0	0	0	0	0	0	1426	0	951	5944
Chain Link Security Fence	0	0	3170	0	0	0	0	0	0	0	7925
Sodding	0	0	0	0	0	0	0	0	0	553	1843
Seeding and Mulching	0	0	0	0	0	0	0	0	0	16039	45825
Pavement Markings	0	0	0	112	0	0	0	0	0	0	1119
Trenching for Electrical Wiring	0	0	0	0	0	0	0	0	0	0	9272
Concrete Duct Banks	0	0	0	0	0	266	0	0	0	0	2664
Cable for Runway Lights	0	0	0	0	5782	0	0	0	0	0	9637
Cable for VASIS/PAPI	0	0	0	0	1278	0	0	0	0	0	2130
Cable for RILS	0	0	0	0	2820	0	0	0	0	0	4367
Cable for Windsock	0	0	0	0	2304	0	0	0	0	0	3840
Counterpoise for Wiring	0	0	0	0	1334	0	0	0	0	0	2223
Runway Edge Lights	0	0	0	0	4932	0	0	0	0	0	10961
Runway Threshold Lights	0	0	0	0	1865	0	0	0	0	0	4145
Taxiway Lights	0	0	0	0	2090	0	0	0	0	0	4645
Apron Edge Lights	0	0	0	0	0	0	0	0	0	0	0
VASIS/PAPI	0	0	0	0	15810	0	0	0	0	0	26350
RILS	0	0	0	0	8868	0	0	0	0	0	14780
Illuminated Windcone	0	0	0	0	6240	0	0	0	0	0	10400
Regulator for Lights	0	0	0	0	13975	0	0	0	0	0	21500
Regulator for VASIS/PAPI	0	0	0	0	15600	0	0	0	0	0	24000
Visual Aids Control System	0	0	0	0	6500	0	0	0	0	0	10000
Meteorological Equipment	0	0	0	0	4875	0	0	0	0	0	7500
Refurbish Air Terminal Building	0	0	0	0	0	0	0	1680	720	0	12000
Field Electrical Centre	0	0	0	0	8640	0	0	0	0	0	16000
New Fuel Tanks	0	0	0	0	0	0	0	22500	0	0	45000
External Power Services	0	0	0	0	39000	0	0	0	0	0	60000
Miscellaneous	0	0	0	0	12140	0	0	0	0	0	48560
Engineering Design	0	0	0	0	0	0	0	0	0	0	111243
Engineering Construction Management	0	0	0	0	0	0	0	0	0	0	88994
Column Total	54872	7839	5570	112	159255	13996	59636	28193	720	23639	1312662
	12	13	14	15	16	17	18	19	20	21	22

Standard Unit Project B2 Major Upgrade of a 3500 ft Runway	Total	Administration		Labour			Equipment			Non-Met. Minerals	Non-Met. Mineral Products
		Overhead	Profit	Wages	Fringe	Fuel	Repairs	Insurance	Depreci-ation		
task											
Tree Planting	21336	1707	427	5569	832	277	213	43	1600	0	0
Clearing	41072	3286	821	14293	2136	2670	2054	411	15402	0	0
Clearing and Grubbing	24803	1984	496	8631	1290	1612	1240	248	9301	0	0
Earth Excavation	79882	6391	1598	29884	4465	4881	3754	751	28158	0	0
Select Subgrade Mix	266273	21302	5325	34749	5192	10039	7722	1544	57914	81657	0
Hot-Mix Asphalt	337834	27027	6757	38209	5709	4392	3378	676	25338	116604	0
Granular "A"	104914	8393	2098	10953	1637	1364	1049	210	7869	47561	0
Granular "B"	174206	13937	3484	18187	2718	2265	1742	348	13066	78974	0
Cutting Existing Pavement	12674	1014	253	6616	989	494	380	76	2852	0	0
150 mm Subdrains	68649	5492	1373	22695	3391	1517	1167	233	8753	0	0
Pumping Station	20000	1600	400	3480	520	260	200	40	1500	0	4200
Culverts	33284	2663	666	12741	1904	1298	999	200	7489	533	0
Water for Compaction	14736	1179	295	5769	862	862	663	133	4973	0	0
Removal of Asphalt	8759	701	175	2286	342	683	526	105	3942	0	0
Removal of Fence	1216	97	24	635	95	47	36	7	274	0	0
Farm Fencing or Posts	10401	832	208	2715	406	270	208	42	1560	0	0
Chain Link Security Fence	13868	1109	277	3620	541	361	277	55	2080	0	0
Sodding	3226	258	65	1403	210	42	32	6	242	0	0
Seeding and Mulching	80195	6416	1604	10465	1564	4170	3208	642	24058	0	0
Pavement Markings	1958	157	39	511	76	127	98	20	734	0	0
Trenching for Electrical Wiring	16226	1298	325	8470	1266	633	487	97	3651	0	0
Concrete Duct Banks	4662	373	93	1217	182	61	47	9	350	0	1865
Cable for Runway Lights	16865	1349	337	4402	658	0	0	0	0	0	0
Cable for VASIS/PAPI	3727	298	75	973	145	0	0	0	0	0	0
Cable for RILS	7643	611	153	1995	298	0	0	0	0	0	0
Cable for Windsock	6721	538	134	1754	262	0	0	0	0	0	0
Counterpoise for Wiring	3891	311	78	1015	152	0	0	0	0	0	0
Runway Edge Lights	19181	1534	384	5006	748	374	288	58	2158	0	0
Runway Threshold Lights	7254	580	145	1893	283	141	109	22	816	0	0
Taxiway Lights	8129	650	163	2122	317	159	122	24	915	0	0
Apron Edge Lights	0	0	0	0	0	0	0	0	0	0	0
VASIS/PAPI	46112	3689	922	8024	1199	599	461	92	3458	0	0
RILS	25865	2069	517	4500	672	336	259	52	1940	0	0
Illuminated Windcone	10400	832	208	1810	270	135	104	21	780	0	0
Regulator for Lights	21500	1720	430	3741	559	140	108	22	806	0	0
Regulator for VASIS/PAPI	24000	1920	480	4176	624	156	120	24	900	0	0
Visual Aids Control System	10000	800	200	1740	260	65	50	10	375	0	0
Meterological Equipment	7500	600	150	1305	195	49	38	8	281	0	0
Refurbish Air Terminal Building	12000	960	240	3132	468	312	240	48	1800	0	2400
Field Electrical Centre	16000	1280	320	2784	416	208	160	32	1200	0	960
New Fuel Tanks	45000	3600	900	7830	1170	1170	900	180	6750	0	0
External Power Services	60000	4800	1200	10440	1560	390	300	60	2250	0	0
Miscellaneous	84980	16996	4249	18483	2762	2762	2125	425	15934	0	0
Engineering Design	177694	49754	12439	100486	15015	0	0	0	0	0	0
Engineering Construction Management	142156	39804	9951	80389	12012	0	0	0	0	0	0
Column Total	2098795	241911	60478	511098	76371	45321	34862	6972	261468	325329	9425
	1	2	3	4	5	6	7	8	9	10	11

SUP B2 (continued)	Petroleum & Coal Products	Tax	Primary Metal Products	Chemicals Chemical Products	Electrical & Comm Products	Plastic Fabricated Products	Trans-port	Metal Fabricated Products	Lumber, Wood Products	Agric. & Forestry Products	Total
Tree Planting	0	0	0	0	0	0	0	0	0	10668	21336
Clearing	0	0	0	0	0	0	0	0	0	0	41072
Clearing and Grubbing	0	0	0	0	0	0	0	0	0	0	24803
Earth Excavation	0	0	0	0	0	0	0	0	0	0	79882
Select Subgrade Mix	0	0	0	0	0	0	40829	0	0	0	266273
Hot-Mix Asphalt	96027	13718	0	0	0	0	0	0	0	0	337834
Granular "A"	0	0	0	0	0	0	23781	0	0	0	104914
Granular "B"	0	0	0	0	0	0	39487	0	0	0	174208
Cutting Existing Pavement	0	0	0	0	0	0	0	0	0	0	12674
150 mm Subdrains	0	0	0	0	0	24027	0	0	0	0	68649
Pumping Station	0	0	2400	0	5400	0	0	0	0	0	20000
Culverts	0	0	0	0	0	0	266	4527	0	0	33284
Water for Compaction	0	0	0	0	0	0	0	0	0	0	14736
Removal of Asphalt	0	0	0	0	0	0	0	0	0	0	8759
Removal of Fence	0	0	0	0	0	0	0	0	0	0	1216
Farm Fencing or Posts	0	0	0	0	0	0	0	2496	0	1664	10401
Chain Link Security Fence	0	0	5547	0	0	0	0	0	0	0	13868
Sodding	0	0	0	0	0	0	0	0	0	968	3226
Seeding and Mulching	0	0	0	0	0	0	0	0	0	28068	80195
Pavement Markings	0	0	0	196	0	0	0	0	0	0	1958
Trenching for Electrical Wiring	0	0	0	0	0	0	0	0	0	0	16226
Concrete Duct Banks	0	0	0	0	0	466	0	0	0	0	4662
Cable for Runway Lights	0	0	0	0	10119	0	0	0	0	0	16865
Cable for VASIS/PAPI	0	0	0	0	2236	0	0	0	0	0	3727
Cable for RILS	0	0	0	0	4586	0	0	0	0	0	7643
Cable for Windsock	0	0	0	0	4033	0	0	0	0	0	6721
Counterpoise for Wiring	0	0	0	0	2334	0	0	0	0	0	3891
Runway Edge Lights	0	0	0	0	8631	0	0	0	0	0	19181
Runway Threshold Lights	0	0	0	0	3264	0	0	0	0	0	7254
Taxiway Lights	0	0	0	0	3658	0	0	0	0	0	8129
Apron Edge Lights	0	0	0	0	0	0	0	0	0	0	0
VASIS/PAPI	0	0	0	0	27667	0	0	0	0	0	46112
RILS	0	0	0	0	15519	0	0	0	0	0	25865
Illuminated Windcone	0	0	0	0	6240	0	0	0	0	0	10400
Regulator for Lights	0	0	0	0	13975	0	0	0	0	0	21500
Regulator for VASIS/PAPI	0	0	0	0	15600	0	0	0	0	0	24000
Visual Aids Control System	0	0	0	0	6500	0	0	0	0	0	10000
Meterological Equipment	0	0	0	0	4875	0	0	0	0	0	7500
Refurbish Air Terminal Building	0	0	0	0	0	0	0	1680	720	0	12000
Field Electrical Centre	0	0	0	0	8640	0	0	0	0	0	16000
New Fuel Tanks	0	0	0	0	0	0	0	22500	0	0	45000
External Power Services	0	0	0	0	39000	0	0	0	0	0	60000
Miscellaneous	0	0	0	0	21245	0	0	0	0	0	84980
Engineering Design	0	0	0	0	0	0	0	0	0	0	177694
Engineering Construction Management	0	0	0	0	0	0	0	0	0	0	142156
Column Total	96027	13718	7947	196	203523	24493	104363	31203	720	41368	2096795
	12	13	14	15	16	17	18	19	20	21	22

Standard Unit Project B3 Major Upgrade of a 5000 ft Runway	Total	Administration		Labour			Equipment			Non-Met. Minerals	Non-Met. Mineral Products
		Overhead	Profit	Wages	Fringe	Fuel	Repairs	Insurance	Depreci-ation		
task											
Tree Planting	30480	2438	610	7955	1189	396	305	61	2286	0	0
Clearing	58674	4694	1173	20419	3051	3814	2934	587	22003	0	0
Clearing and Grubbing	35433	2835	709	12331	1843	2303	1772	354	13287	0	0
Earth Excavation	114117	9129	2282	42691	6379	6973	5364	1073	40226	0	0
Select Subgrade Mix	380390	30431	7608	49641	7418	14341	11031	2206	82735	116653	0
Hot-Mix Asphalt	482620	38610	9652	54584	8156	6274	4826	965	36197	166577	0
Granular "A"	149878	11990	2998	15647	2338	1948	1499	300	11241	67945	0
Granular "B"	248869	19910	4977	25982	3882	3235	2489	498	18665	112821	0
Cutting Existing Pavement	18105	1448	362	9451	1412	706	543	109	4074	0	0
150 mm Subdrains	98069	7846	1961	32422	4845	2167	1667	333	12504	0	0
Pumping Station	20000	1600	400	3480	520	260	200	40	1500	0	4200
Culverts	47549	3804	951	18202	2720	1854	1426	285	10698	761	0
Water for Compaction	21051	1684	421	8241	1231	1231	947	189	7105	0	0
Removal of Asphalt	12514	1001	250	3266	488	976	751	150	5631	0	0
Removal of Fence	1737	139	35	907	136	68	52	10	391	0	0
Farm Fencing or Posts	14859	1189	297	3878	580	386	297	59	2229	0	0
Chain Link Security Fence	19812	1585	396	5171	773	515	396	79	2972	0	0
Sodding	4609	369	92	2005	300	60	46	9	346	0	0
Seeding and Mulching	114564	9165	2291	14951	2234	5957	4583	917	34369	0	0
Pavement Markings	2797	224	56	730	109	182	140	28	1049	0	0
Trenching for Electrical Wiring	23180	1854	464	12100	1808	904	695	139	5216	0	0
Concrete Duct Banks	6660	533	133	1738	260	87	67	13	499	0	2664
Cable for Runway Lights	24093	1927	482	6288	940	0	0	0	0	0	0
Cable for VASIS/PAPI	5325	426	106	1390	208	0	0	0	0	0	0
Cable for RILS	10918	873	218	2850	426	0	0	0	0	0	0
Cable for Windsock	9601	768	192	2506	374	0	0	0	0	0	0
Counterpoise for Wiring	5558	445	111	1451	217	0	0	0	0	0	0
Runway Edge Lights	27402	2192	548	7152	1069	534	411	82	3083	0	0
Runway Threshold Lights	10363	829	207	2705	404	202	155	31	1166	0	0
Taxiway Lights	11613	929	232	3031	453	226	174	35	1306	0	0
Apron Edge Lights	0	0	0	0	0	0	0	0	0	0	0
VASIS/PAPI	65875	5270	1317	11462	1713	856	659	132	4941	0	0
RILS	36949	2956	739	6429	961	480	369	74	2771	0	0
Illuminated Windcone	10400	832	208	1810	270	135	104	21	780	0	0
Regulator for Lights	21500	1720	430	3741	559	140	108	22	806	0	0
Regulator for VASIS/PAPI	24000	1920	480	4176	624	156	120	24	900	0	0
Visual Aids Control System	10000	800	200	1740	260	65	50	10	375	0	0
Meterological Equipment	7500	600	150	1305	195	49	38	8	281	0	0
Refurbish Air Terminal Building	12000	960	240	3132	468	312	240	48	1800	0	2400
Field Electrical Centre	16000	1280	320	2784	416	208	160	32	1200	0	960
New Fuel Tanks	45000	3600	900	7830	1170	1170	900	180	6750	0	0
External Power Services	60000	4800	1200	10440	1560	390	300	60	2250	0	0
Miscellaneous	121400	24280	6070	26405	3946	3946	3035	607	22763	0	0
Engineering Design	244146	68361	17090	138065	20630	0	0	0	0	0	0
Engineering Construction Management	195317	54689	13672	110452	16504	0	0	0	0	0	0
Column Total	2880927	332935	83234	702933	105036	63508	48852	9770	386394	484756	10224
	1	2	3	4	5	6	7	8	9	10	11

SUP B3 (continued)	Petroleum & Coal Products	Tax	Primary Metal Products	Chemicals Chemical Products	Electrical & Comm Products	Plastic Fabricated Products	Trans-port	Metal Fabricated Products	Lumber, Wood Products	Agric. & Forestry Products	Total
Tree Planting	0	0	0	0	0	0	0	0	0	15240	30480
Clearing	0	0	0	0	0	0	0	0	0	0	58674
Clearing and Grubbing	0	0	0	0	0	0	0	0	0	0	35433
Earth Excavation	0	0	0	0	0	0	0	0	0	0	114117
Select Subgrade Mix	0	0	0	0	0	0	58327	0	0	0	380390
Hot-Mix Asphalt	137181	19597	0	0	0	0	0	0	0	0	482620
Granular "A"	0	0	0	0	0	0	33972	0	0	0	149878
Granular "B"	0	0	0	0	0	0	56410	0	0	0	248869
Cutting Existing Pavement	0	0	0	0	0	0	0	0	0	0	18105
150 mm Subdrains	0	0	0	0	0	34324	0	0	0	0	98069
Pumping Station	0	0	2400	0	5400	0	0	0	0	0	20000
Culverts	0	0	0	0	0	0	380	6487	0	0	47549
Water for Compaction	0	0	0	0	0	0	0	0	0	0	21051
Removal of Asphalt	0	0	0	0	0	0	0	0	0	0	12514
Removal of Fence	0	0	0	0	0	0	0	0	0	0	1737
Farm Fencing or Posts	0	0	0	0	0	0	0	3566	0	2377	14859
Chain Link Security Fence	0	0	7925	0	0	0	0	0	0	0	19812
Sodding	0	0	0	0	0	0	0	0	0	1383	4609
Seeding and Mulching	0	0	0	0	0	0	0	0	0	40097	114564
Pavement Markings	0	0	0	280	0	0	0	0	0	0	2797
Trenching for Electrical Wiring	0	0	0	0	0	0	0	0	0	0	23180
Concrete Duct Banks	0	0	0	0	0	666	0	0	0	0	6660
Cable for Runway Lights	0	0	0	0	14456	0	0	0	0	0	24093
Cable for VASIS/PAPI	0	0	0	0	3195	0	0	0	0	0	5325
Cable for RILS	0	0	0	0	6551	0	0	0	0	0	10918
Cable for Windsock	0	0	0	0	5761	0	0	0	0	0	9601
Counterpoise for Wiring	0	0	0	0	3335	0	0	0	0	0	5558
Runway Edge Lights	0	0	0	0	12331	0	0	0	0	0	27402
Runway Threshold Lights	0	0	0	0	4663	0	0	0	0	0	10363
Taxiway Lights	0	0	0	0	5226	0	0	0	0	0	11613
Apron Edge Lights	0	0	0	0	0	0	0	0	0	0	0
VASIS/PAPI	0	0	0	0	39525	0	0	0	0	0	65875
RILS	0	0	0	0	22170	0	0	0	0	0	36949
Illuminated Windcone	0	0	0	0	6240	0	0	0	0	0	10400
Regulator for Lights	0	0	0	0	13975	0	0	0	0	0	21500
Regulator for VASIS/PAPI	0	0	0	0	15800	0	0	0	0	0	24000
Visual Aids Control System	0	0	0	0	6500	0	0	0	0	0	10000
Meterological Equipment	0	0	0	0	4875	0	0	0	0	0	7500
Refurbish Air Terminal Building	0	0	0	0	0	0	0	1680	720	0	12000
Field Electrical Centre	0	0	0	0	8640	0	0	0	0	0	16000
New Fuel Tanks	0	0	0	0	0	0	0	22500	0	0	45000
External Power Services	0	0	0	0	39000	0	0	0	0	0	60000
Miscellaneous	0	0	0	0	30350	0	0	0	0	0	121400
Engineering Design	0	0	0	0	0	0	0	0	0	0	244146
Engineering Construction Management	0	0	0	0	0	0	0	0	0	0	195317
Column Total	137181	19597	10325	280	247792	34990	149090	34213	720	59097	2880927
	12	13	14	15	16	17	18	19	20	21	22

Standard Unit Project B4 Navaid Upgrade of a 2000 ft Runway	Total	Administration		Labour			Equipment			Non-Met. Minerals	Non-Met. Mineral Products
		Overhead	Profit	Wages	Fringe	Fuel	Repairs	Insurance	Depreci-ation		
task											
Trenching for Electrical Wiring	9272	742	185	4840	723	362	278	56	2066	0	0
Concrete Duct Banks	2664	213	53	695	104	35	27	5	200	0	1066
Cable for Runway Lights	9637	771	193	2515	376	0	0	0	0	0	0
Cable for VASIS/PAPI	2130	170	43	556	83	0	0	0	0	0	0
Cable for RILS	4367	349	87	1140	170	0	0	0	0	0	0
Cable for Windsock	3840	307	77	1002	150	0	0	0	0	0	0
Counterpoise for Wiring	2223	178	44	580	87	0	0	0	0	0	0
Runway Edge Lights	10961	877	219	2861	427	214	164	33	1233	0	0
Runway Threshold Lights	4145	332	83	1082	162	81	62	12	466	0	0
Taxiway Lights	4645	372	93	1212	181	91	70	14	523	0	0
Apron Edge Lights	0	0	0	0	0	0	0	0	0	0	0
VASIS/PAPI	26350	2108	527	4585	685	343	263	53	1976	0	0
RILS	14780	1182	296	2572	384	192	148	30	1108	0	0
Illuminated Windcone	10400	832	208	1810	270	135	104	21	780	0	0
Regulator for Lights	21500	1720	430	3741	559	140	108	22	806	0	0
Regulator for VASIS/PAPI	24000	1920	480	4176	624	156	120	24	900	0	0
Visual Aids Control System	10000	800	200	1740	260	65	50	10	375	0	0
Meterological Equipment	7500	600	150	1305	195	49	38	8	281	0	0
Field Electrical Centre	16000	1280	320	2784	416	208	160	32	1200	0	960
External Power Services	60000	4800	1200	10440	1560	390	300	60	2250	0	0
Engineering Design	24441	6844	1711	13822	2065	0	0	0	0	0	0
Engineering Construction Management	19553	5475	1369	11057	1652	0	0	0	0	0	0
Column Total	288409	31872	7968	74515	11134	2459	1891	378	14185	0	2026
	1	2	3	4	5	6	7	8	9	10	11

SUP B4 (continued)	Petroleum & Coal Products	Tax	Primary Metal Products	Chemicals Chemical Products	Electrical & Comm Products	Plastic Fabricated Products	Trans-port	Metal Fabricated Products	Lumber, Wood Products	Agric. & Forestry Products	Total
Trenching for Electrical Wiring	0	0	0	0	0	0	0	0	0	0	9272
Concrete Duct Banks	0	0	0	0	0	266	0	0	0	0	2664
Cable for Runway Lights	0	0	0	0	5782	0	0	0	0	0	9637
Cable for VASIS/PAPI	0	0	0	0	1278	0	0	0	0	0	2130
Cable for RILS	0	0	0	0	2620	0	0	0	0	0	4367
Cable for Windsock	0	0	0	0	2304	0	0	0	0	0	3840
Counterpoise for Wiring	0	0	0	0	1334	0	0	0	0	0	2223
Runway Edge Lights	0	0	0	0	4932	0	0	0	0	0	10961
Runway Threshold Lights	0	0	0	0	1865	0	0	0	0	0	4145
Taxiway Lights	0	0	0	0	2090	0	0	0	0	0	4645
Apron Edge Lights	0	0	0	0	0	0	0	0	0	0	0
VASIS/PAPI	0	0	0	0	15810	0	0	0	0	0	26350
RILS	0	0	0	0	8868	0	0	0	0	0	14780
Illuminated Windcone	0	0	0	0	6240	0	0	0	0	0	10400
Regulator for Lights	0	0	0	0	13975	0	0	0	0	0	21500
Regulator for VASIS/PAPI	0	0	0	0	15600	0	0	0	0	0	24000
Visual Aids Control System	0	0	0	0	6500	0	0	0	0	0	10000
Meterological Equipment	0	0	0	0	4875	0	0	0	0	0	7500
Field Electrical Centre	0	0	0	0	8640	0	0	0	0	0	16000
External Power Services	0	0	0	0	39000	0	0	0	0	0	60000
Engineering Design	0	0	0	0	0	0	0	0	0	0	24441
Engineering Construction Management	0	0	0	0	0	0	0	0	0	0	19553
Column Total	0	0	0	0	141715	266	0	0	0	0	288409
	12	13	14	15	16	17	18	19	20	21	22

Standard Unit Project B5 Navaid Upgrade of a 3500 ft Runway	Total	Administration		Labour		Fuel	Equipment			Non-Met. Minerals	Non-Met. Mineral Products
		Overhead	Profit	Wages	Fringe		Repairs	Insurance	Depreciation		
task											
Trenching for Electrical Wiring	16226	1298	325	8470	1266	633	487	97	3651	0	0
Concrete Duct Banks	4662	373	93	1217	182	61	47	9	350	0	1865
Cable for Runway Lights	16865	1349	337	4402	658	0	0	0	0	0	0
Cable for VASIS/PAPI	3727	298	75	973	145	0	0	0	0	0	0
Cable for RILS	7643	611	153	1995	298	0	0	0	0	0	0
Cable for Windsock	6721	538	134	1754	262	0	0	0	0	0	0
Counterpoise for Wiring	3891	311	78	1015	152	0	0	0	0	0	0
Runway Edge Lights	19181	1534	384	5006	748	374	288	58	2158	0	0
Runway Threshold Lights	7254	580	145	1893	283	141	109	22	816	0	0
Taxiway Lights	8129	650	163	2122	317	159	122	24	915	0	0
Apron Edge Lights	0	0	0	0	0	0	0	0	0	0	0
VASIS/PAPI	46112	3689	922	8024	1199	599	461	92	3458	0	0
RILS	25865	2069	517	4500	672	336	259	52	1940	0	0
Illuminated Windcone	10400	832	208	1810	270	135	104	21	780	0	0
Regulator for Lights	21500	1720	430	3741	559	140	108	22	806	0	0
Regulator for VASIS/PAPI	24000	1920	480	4176	624	156	120	24	900	0	0
Visual Aids Control System	10000	800	200	1740	260	65	50	10	375	0	0
Meterological Equipment	7500	600	150	1305	195	49	38	8	281	0	0
Field Electrical Centre	16000	1280	320	2784	416	208	160	32	1200	0	960
External Power Services	60000	4800	1200	10440	1560	390	300	60	2250	0	0
Engineering Design	31568	8839	2210	17851	2667	0	0	0	0	0	0
Engineering Construction Management	25254	7071	1768	14281	2134	0	0	0	0	0	0
Column Total	372497	41164	10291	99499	14868	3446	2651	530	19880	0	2825
	1	2	3	4	5	6	7	8	9	10	11

SUP B5 (continued)	Petroleum & Coal Products	Tax	Primary Metal Products	Chemicals Chemical Products	Electrical & Comm Products	Plastic Fabricated Products	Transport	Metal Fabricated Products	Lumber, Wood Products	Agric. & Forestry Products	Total
Trenching for Electrical Wiring	0	0	0	0	0	0	0	0	0	0	16226
Concrete Duct Banks	0	0	0	0	0	466	0	0	0	0	4662
Cable for Runway Lights	0	0	0	0	10119	0	0	0	0	0	16865
Cable for VASIS/PAPI	0	0	0	0	2236	0	0	0	0	0	3727
Cable for RILS	0	0	0	0	4586	0	0	0	0	0	7643
Cable for Windsock	0	0	0	0	4033	0	0	0	0	0	6721
Counterpoise for Wiring	0	0	0	0	2334	0	0	0	0	0	3891
Runway Edge Lights	0	0	0	0	8631	0	0	0	0	0	19181
Runway Threshold Lights	0	0	0	0	3264	0	0	0	0	0	7254
Taxiway Lights	0	0	0	0	3658	0	0	0	0	0	8129
Apron Edge Lights	0	0	0	0	0	0	0	0	0	0	0
VASIS/PAPI	0	0	0	0	27667	0	0	0	0	0	46112
RILS	0	0	0	0	15519	0	0	0	0	0	25865
Illuminated Windcone	0	0	0	0	6240	0	0	0	0	0	10400
Regulator for Lights	0	0	0	0	13975	0	0	0	0	0	21500
Regulator for VASIS/PAPI	0	0	0	0	15600	0	0	0	0	0	24000
Visual Aids Control System	0	0	0	0	6500	0	0	0	0	0	10000
Meterological Equipment	0	0	0	0	4875	0	0	0	0	0	7500
Field Electrical Centre	0	0	0	0	8640	0	0	0	0	0	16000
External Power Services	0	0	0	0	39000	0	0	0	0	0	60000
Engineering Design	0	0	0	0	0	0	0	0	0	0	31568
Engineering Construction Management	0	0	0	0	0	0	0	0	0	0	25254
Column Total	0	0	0	0	176878	466	0	0	0	0	372497
	12	13	14	15	16	17	18	19	20	21	22

Standard Unit Project 36 Navaid Upgrade of a 5000 ft Runway	Total	Administration		Labour			Equipment			Non-Met. Minerals	Non-Met. Mineral Products
		Overhead	Profit	Wages	Fringe	Fuel	Repairs	Insurance	Depreciation		
task											
Trenching for Electrical Wiring	23180	1854	464	12100	1808	904	695	139	5216	0	0
Concrete Duct Banks	6660	533	133	1738	260	87	67	13	499	0	2664
Cable for Runway Lights	24093	1927	482	6288	940	0	0	0	0	0	0
Cable for VASIS/PAPI	5325	426	106	1390	208	0	0	0	0	0	0
Cable for RILS	10918	873	218	2850	426	0	0	0	0	0	0
Cable for Windsock	9601	768	192	2506	374	0	0	0	0	0	0
Counterpoise for Wiring	5558	445	111	1451	217	0	0	0	0	0	0
Runway Edge Lights	27402	2192	548	7152	1069	534	411	82	3083	0	0
Runway Threshold Lights	10363	829	207	2705	404	202	155	31	1166	0	0
Taxiway Lights	11613	929	232	3031	453	226	174	35	1306	0	0
Apron Edge Lights	0	0	0	0	0	0	0	0	0	0	0
VASIS/PAPI	65875	5270	1317	11462	1713	856	659	132	4941	0	0
RILS	36949	2956	739	6429	961	480	369	74	2771	0	0
Illuminated Windcone	10400	832	208	1810	270	135	104	21	780	0	0
Regulator for Lights	21500	1720	430	3741	559	140	108	22	806	0	0
Regulator for VASIS/PAPI	24000	1920	480	4176	624	156	120	24	900	0	0
Visual Aids Control System	10000	800	200	1740	260	65	50	10	375	0	0
Meterological Equipment	7500	600	150	1305	195	49	38	8	281	0	0
Field Electrical Centre	16000	1280	320	2784	416	208	160	32	1200	0	960
External Power Services	60000	4800	1200	10440	1560	390	300	60	2250	0	0
Engineering Design	38694	10834	2709	21881	3270	0	0	0	0	0	0
Engineering Construction Management	30955	8667	2167	17505	2616	0	0	0	0	0	0
Column Total	456585	50457	12614	124483	18601	4433	3410	682	25574	0	3624
	1	2	3	4	5	6	7	8	9	10	11

SUP 86 (continued)	Petroleum & Coal Products	Tax	Primary Metal Products	Chemicals Chemical Products	Electrical & Comm Products	Plastic Fabricated Products	Transport	Metal Fabricated Products	Lumber, Wood Products	Agric. & Forestry Products	Total
Trenching for Electrical Wiring	0	0	0	0	0	0	0	0	0	0	23180
Concrete Duct Banks	0	0	0	0	0	666	0	0	0	0	6660
Cable for Runway Lights	0	0	0	0	14456	0	0	0	0	0	24093
Cable for VASIS/PAPI	0	0	0	0	3195	0	0	0	0	0	5325
Cable for RILS	0	0	0	0	6551	0	0	0	0	0	10918
Cable for Windsock	0	0	0	0	5761	0	0	0	0	0	9601
Counterpoise for Wiring	0	0	0	0	3335	0	0	0	0	0	5558
Runway Edge Lights	0	0	0	0	12331	0	0	0	0	0	27402
Runway Threshold Lights	0	0	0	0	4663	0	0	0	0	0	10363
Taxiway Lights	0	0	0	0	5226	0	0	0	0	0	11613
Apron Edge Lights	0	0	0	0	0	0	0	0	0	0	0
VASIS/PAPI	0	0	0	0	39525	0	0	0	0	0	65875
RILS	0	0	0	0	22170	0	0	0	0	0	36949
Illuminated Windcone	0	0	0	0	6240	0	0	0	0	0	10400
Regulator for Lights	0	0	0	0	13975	0	0	0	0	0	21500
Regulator for VASIS/PAPI	0	0	0	0	15600	0	0	0	0	0	24000
Visual Aids Control System	0	0	0	0	6500	0	0	0	0	0	10000
Meterological Equipment	0	0	0	0	4875	0	0	0	0	0	7500
Field Electrical Centre	0	0	0	0	8640	0	0	0	0	0	16000
External Power Services	0	0	0	0	39000	0	0	0	0	0	60000
Engineering Design	0	0	0	0	0	0	0	0	0	0	38694
Engineering Construction Management	0	0	0	0	0	0	0	0	0	0	30955
Column Total	0	0	0	0	212041	666	0	0	0	0	456585
	12	13	14	15	16	17	18	19	20	21	22

Standard Unit Project B7 Minor Upgrade of a 2000 ft Runway	Total	Administration		Labour			Equipment			Non-Met. Minerals	Non-Met. Mineral Products
task		Overhead	Profit	Wages	Fringe	Fuel	Repairs	Insurance	Depreci-ation		
Earth Excavation	22823	1826	456	8538	1276	1395	1073	215	8045	0	0
Select Subgrade Mix	76078	6086	1522	9928	1484	2868	2206	441	16547	23331	0
Hot-Mix Asphalt	193048	15444	3861	21834	3263	2510	1930	386	14479	66631	0
Granular "A"	29976	2398	600	3129	468	390	300	60	2248	13589	0
Granular "B"	49774	3982	995	5196	776	647	498	100	3733	22564	0
150 mm Subdrains	39228	3138	785	12969	1938	867	667	133	5002	0	0
Seeding and Mulching	45825	3666	917	5980	894	2383	1833	367	13748	0	0
Engineering Design	45675	12789	3197	25829	3860	0	0	0	0	0	0
Engineering Construction Management	36540	10231	2558	20663	3088	0	0	0	0	0	0
Column Total	538968	59560	14890	114068	17045	11059	8507	1701	63801	126115	0
	1	2	3	4	5	6	7	8	9	10	11

SUP B7 (continued)	Petroleum & Coal Products	Tax	Primary Metal Products	Chemicals Chemical Products	Electrical & Comm Products	Plastic Fabricated Products	Trans-port	Metal Fabricated Products	Lumber, Wood Products	Agric. & Forestry Products	Total
Earth Excavation	0	0	0	0	0	0	0	0	0	0	22823
Select Subgrade Mix	0	0	0	0	0	0	11665	0	0	0	76078
Hot-Mix Asphalt	54872	7839	0	0	0	0	0	0	0	0	193048
Granular "A"	0	0	0	0	0	0	6794	0	0	0	29976
Granular "B"	0	0	0	0	0	0	11282	0	0	0	49774
150 mm Subdrains	0	0	0	0	0	13730	0	0	0	0	39228
Seeding and Mulching	0	0	0	0	0	0	0	0	0	16039	45825
Engineering Design	0	0	0	0	0	0	0	0	0	0	45675
Engineering Construction Management	0	0	0	0	0	0	0	0	0	0	36540
Column Total	54872	7839	0	0	0	13730	29742	0	0	16039	538968
	12	13	14	15	16	17	18	19	20	21	22

Standard Unit Project B8
Minor Upgrade of a 3500 ft Runway

task	Total	Administration		Labour		Equipment				Non-Met. Minerals	Non-Met. Mineral Products
		Overhead	Profit	Wages	Fringe	Fuel	Repairs	Insurance	Depreci-ation		
Earth Excavation	39941	3195	799	14942	2233	2440	1877	375	14079	0	0
Select Subgrade Mix	133137	10651	2663	17374	2596	5019	3861	772	28957	40829	0
Hot-Mix Asphalt	337834	27027	6757	38209	5709	4392	3378	676	25338	116604	0
Granular "A"	52457	4197	1049	5477	818	682	525	105	3934	23781	0
Granular "B"	87104	6968	1742	9094	1359	1132	871	174	6533	39487	0
150 mm Subdrains	68649	5492	1373	22695	3391	1517	1167	233	8753	0	0
Seeding and Mulching	80195	6416	1604	10465	1564	4170	3208	642	24058	0	0
Engineering Design	79932	22381	5595	45201	6754	0	0	0	0	0	0
Engineering Construction Management	63945	17905	4476	36161	5403	0	0	0	0	0	0
Column Total	943193	104231	26058	199619	29828	19353	14887	2977	111652	220700	0
	1	2	3	4	5	6	7	8	9	10	11

SUP B8 (continued)

	Petroleum & Coal Products	Tax	Primary Metal Products	Chemicals Chemical Products	Electrical & Comm Products	Plastic Fabricated Products	Trans-port	Metal Fabricated Products	Lumber, Wood Products	Agric. & Forestry Products	Total
Earth Excavation	0	0	0	0	0	0	0	0	0	0	39941
Select Subgrade Mix	0	0	0	0	0	0	20414	0	0	0	133137
Hot-Mix Asphalt	96027	13718	0	0	0	0	0	0	0	0	337834
Granular "A"	0	0	0	0	0	0	11890	0	0	0	52457
Granular "B"	0	0	0	0	0	0	19744	0	0	0	87104
150 mm Subdrains	0	0	0	0	0	24027	0	0	0	0	68649
Seeding and Mulching	0	0	0	0	0	0	0	0	0	28068	80195
Engineering Design	0	0	0	0	0	0	0	0	0	0	79932
Engineering Construction Management	0	0	0	0	0	0	0	0	0	0	63945
Column Total	96027	13718	0	0	0	24027	52048	0	0	28068	943193
	12	13	14	15	16	17	18	19	20	21	22

Standard Unit Project B9 Minor Upgrade of a 5000 ft Runway	Total	Administration		Labour			Equipment			Non-Met. Minerals	Non-Met. Mineral Products
		Overhead	Profit	Wages	Fringe	Fuel	Repairs	Insurance	Depreci-ation		
task											
Earth Excavation	57059	4565	1141	21346	3190	3486	2682	536	20113	0	0
Select Subgrade Mix	190195	15216	3804	24820	3709	7170	5516	1103	41367	58327	0
Hot-Mix Asphalt	482620	38610	9652	54584	8156	6274	4826	965	36197	166577	0
Granular "A"	74939	5995	1499	7824	1169	974	749	150	5620	33972	0
Granular "B"	124435	9955	2489	12991	1941	1618	1244	249	9333	56410	0
150 mm Subdrains	98069	7846	1961	32422	4845	2167	1667	333	12504	0	0
Seeding and Mulching	114564	9165	2291	14951	2234	5957	4583	917	34369	0	0
Engineering Design	114188	31973	7993	64573	9649	0	0	0	0	0	0
Engineering Construction Management	91350	25578	6395	51659	7719	0	0	0	0	0	0
Column Total	1347419	148901	37225	285169	42612	27647	21267	4253	159503	315286	0
	1	2	3	4	5	6	7	8	9	10	11

SUP B9 (continued)	Petroleum & Coal Products	Tax	Primary Metal Products	Chemicals Chemical Products	Electrical & Comm Products	Plastic Fabricated Products	Trans-port	Metal Fabricated Products	Lumber, Wood Products	Agric. & Forestry Products	Total
Earth Excavation	0	0	0	0	0	0	0	0	0	0	57059
Select Subgrade Mix	0	0	0	0	0	0	29163	0	0	0	190195
Hot-Mix Asphalt	137181	19597	0	0	0	0	0	0	0	0	482620
Granular "A"	0	0	0	0	0	0	16986	0	0	0	74939
Granular "B"	0	0	0	0	0	0	28205	0	0	0	124435
150 mm Subdrains	0	0	0	0	0	34324	0	0	0	0	98069
Seeding and Mulching	0	0	0	0	0	0	0	0	0	40097	114564
Engineering Design	0	0	0	0	0	0	0	0	0	0	114188
Engineering Construction Management	0	0	0	0	0	0	0	0	0	0	91350
Column Total	137181	19597	0	0	0	34324	74355	0	0	40097	1347419
	12	13	14	15	16	17	18	19	20	21	22

Standard Unit Project B10 Airport Access Road, 200 m Long	Total	Administration		Labour			Equipment			Non-Met. Minerals
		Overhead	Profit	Wages	Fringe	Fuel	Repairs	Insurance	Depreci-ation	
task										
Excavation for Widening, Deficiencies	1560	125	31	231	34	148	114	23	854	0
Granular "A"	4030	322	81	526	79	152	117	23	877	1236
Ditching	4800	384	96	710	106	456	350	70	2628	0
Supply and Lay Cold-Mix Surface Course	6370	510	127	720	108	83	64	13	478	1194
Surface Treatment	1800	144	36	204	30	23	18	4	135	337
Granular "A" in Shoulders	1040	83	21	136	20	39	30	6	226	310
Relocations, Miscellaneous	3920	784	196	853	127	127	98	20	735	131
Engineering Design	1176	329	82	665	99	0	0	0	0	0
Engineering Construction Management	1176	329	82	665	99	0	0	0	0	0
Column Total	25872	3011	753	4709	704	1028	791	158	5933	3217
	1	2	3	4	5	6	7	8	9	10

SUP B10 (continued)	Non-Met. Mineral Products	Petroleum & Coal Products	Tax	Primary Metal Products	Chemicals Chemical Products	Electrical & Comm Products	Metal Fabricated Products	Trans-port	Total
Excavation for Widening, Deficiencies	0	0	0	0	0	0	0	0	1560
Granular "A"	0	0	0	0	0	0	0	618	4030
Ditching	0	0	0	0	0	0	0	0	4800
Supply and Lay Cold-Mix Surface Course	0	2140	336	0	0	0	0	597	6370
Surface Treatment	0	605	95	0	0	0	0	169	1800
Granular "A" in Shoulders	0	0	0	0	0	0	0	159	1040
Relocations, Miscellaneous	0	0	0	588	0	0	196	65	3920
Engineering Design	0	0	0	0	0	0	0	0	1176
Engineering Construction Management	0	0	0	0	0	0	0	0	1176
Column Total	0	2745	431	588	0	0	196	1609	25872
	11	12	13	14	15	16	17	18	19

Standard Unit Project B11 Airport Access Road, 500 m Long	Total	Administration		Labour			Equipment			Non-Met. Minerals
		Overhead	Profit	Wages	Fringe	Fuel	Repairs	Insurance	Depreci-ation	
task										
Excavation for Widening, Deficiencies	3900	312	78	577	86	370	285	57	2135	0
Granular "A"	10075	806	202	1315	196	380	292	58	2191	3090
Ditching	12000	960	240	1775	265	1139	876	175	6570	0
Supply and Lay Cold-Mix Surface Course	15925	1274	319	1801	269	207	159	32	1194	2985
Surface Treatment	4500	360	90	509	76	59	45	9	338	844
Granular "A" in Shoulders	2600	208	52	339	51	98	75	15	566	797
Relocations, Miscellaneous	24500	4900	1225	5329	796	796	613	123	4594	817
Engineering Design	3675	1029	257	2078	311	0	0	0	0	0
Engineering Construction Management	3675	1029	257	2078	311	0	0	0	0	0
Column Total	80850	10878	2720	15801	2361	3049	2345	469	17588	8533
	1	2	3	4	5	6	7	8	9	10

SUP B11 (continued)	Non-Met. Mineral Products	Petroleum & Coal Products	Tax	Primary Metal Products	Chemicals Chemical Products	Electrical & Comm Products	Metal Fabricated Products	Trans-port	Total
Excavation for Widening, Deficiencies	0	0	0	0	0	0	0	0	3900
Granular "A"	0	0	0	0	0	0	0	1545	10075
Ditching	0	0	0	0	0	0	0	0	12000
Supply and Lay Cold-Mix Surface Course	0	5351	841	0	0	0	0	1493	15925
Surface Treatment	0	1512	238	0	0	0	0	422	4500
Granular "A" in Shoulders	0	0	0	0	0	0	0	399	2600
Relocations, Miscellaneous	0	0	0	3675	0	0	1225	408	24500
Engineering Design	0	0	0	0	0	0	0	0	3675
Engineering Construction Management	0	0	0	0	0	0	0	0	3675
Column Total	0	6863	1078	3675	0	0	1225	4266	80850
	11	12	13	14	15	16	17	18	19

Standard Unit Projects C1-C10 Provincial Highways	Total	Administration		Labour		Equipment			Non-Met. Minerals	Non-Met. Mineral Products	Petroleum & Coal Products
		Overhead	Profit	Wages & Fringe	Fuel	Repairs	Insurance	Depreciation			
task											
1. New Construction – Unpaved, Two Lanes	370658	37066	27212	135675	54478	58864	2984	44493	0	59	0
2. New Construction – Paved, Four Lanes, No Structures	1823293	182329	120431	355951	215759	205978	10900	158835	142630	32320	250146
3. Reconstruction – Paved, Two Lanes	296713	29671	19199	117093	29433	29796	1340	22265	4613	3027	21858
4. Reconstruction – Paved, Two Lanes, Recycling	330821	33082	23132	115956	41432	44710	2261	33788	857	562	13528
5. Resurfacing, Two Lanes with Grading	57989	5799	3661	14845	4547	5142	280	3916	881	379	17130
6. Resurfacing, Recycled Hot-Mix, Two Lanes	55059	5506	3858	18223	6945	7495	379	5664	232	36	5443
7. Post-Tensioned Concrete Structure, Cast in Place	713	71	56	173	10	38	3	18	0	83	0
8. Bridge Deck Repairs – Latex-Modified Concrete Overlay	119	12	7	24	8	9	0	7	0	3	5
9. Bridge Deck Repairs – Latex Patching, Asphalt Overlay	118	12	7	20	9	8	0	6	9	1	16
10. Major Widening, Two Lanes to Four Lanes, No Structures	634204	63420	40046	104206	71218	59352	3042	45783	59969	32874	116712
	1	2	3	4	5	6	7	8	9	10	11

SUPs C1-C10 (continued)	Tax	Primary Metal Products	Chemicals Chemical Products	Electrical & Comm Products	Plastic Fabricated Products	Transport	Metal Fabricated Products	Lumber, Wood Products	Agric. & Forestry Products	Total
1. New Construction – Unpaved, Two Lanes	3033	0	0	0	0	1072	5522	51	150	370658
2. New Construction – Paved, Four Lanes, No Structures	16603	71715	6864	14691	10595	3877	16454	7216	0	1823293
3. Reconstruction – Paved, Two Lanes	1378	0	2020	649	520	489	13068	75	220	296713
4. Reconstruction – Paved, Two Lanes, Recycling	2302	0	16630	0	0	813	1259	130	381	330821
5. Resurfacing, Two Lanes with Grading	283	0	559	0	48	100	380	10	30	57989
6. Resurfacing, Recycled Hot-Mix, Two Lanes	385	0	314	0	75	136	352	4	11	55059
7. Post-Tensioned Concrete Structure, Cast in Place	5	96	0	0	19	1	112	26	0	713
8. Bridge Deck Repairs – Latex-Modified Concrete Overlay	0	19	0	0	21	0	0	2	0	119
9. Bridge Deck Repairs – Latex Patching, Asphalt Overlay	0	10	12	0	7	0	0	1	0	118
10. Major Widening, Two Lanes to Four Lanes, No Structures	5067	9938	2954	3793	4559	1085	7080	3105	0	634204
	12	13	14	15	16	17	18	19	20	21

Standard Unit Project D1
Suburban Parking Lot Construction, 200 Spaces

Task	Total	Administration		Labour		Equipment				Non-Met. Minerals
		Overhead	Profit	Wages	Fringe	Fuel	Repairs	Insurance	Depreciation	
Excavation	7000	560	140	2619	391	428	329	66	2468	0
Granular "A"	13200	1056	264	4708	704	669	515	103	3661	880
Asphalt Surface	8800	704	176	995	149	114	88	18	660	3344
Concrete Curbs	10500	840	210	2466	369	164	126	25	945	0
Catchbasins	7200	576	144	564	84	84	65	13	486	104
Storm Sewer	35000	2800	700	13398	2002	1365	1050	210	7875	1120
Illumination	40000	3200	800	10440	1560	780	600	120	4500	0
Miscellaneous	18255	3651	913	3970	593	593	456	91	3423	0
Engineering Design	11196	3135	784	6332	946	0	0	0	0	0
Construction Supervision	9797	2743	686	5540	828	0	0	0	0	0
Column Total	160948	19265	4816	51033	7626	4196	3229	646	24217	5448
	1	2	3	4	5	6	7	8	9	10

SUP D1 (continued)

Task	Non-Met. Mineral Products	Petroleum & Coal Products	Tax	Primary Metal Products	Chemicals Chemical Products	Electrical & Comm Products	Metal Fabricated Products	Transport	Total
Excavation	0	0	0	0	0	0	0	0	7000
Granular "A"	0	0	0	0	0	0	0	440	13200
Asphalt Surface	0	2200	352	0	0	0	0	0	8800
Concrete Curbs	5355	0	0	0	0	0	0	0	10500
Catchbasins	2436	0	0	2592	0	0	0	52	7200
Storm Sewer	3920	0	0	0	0	0	0	560	35000
Illumination	0	0	0	0	0	7200	10800	0	40000
Miscellaneous	2282	0	0	913	1369	0	0	0	18255
Engineering Design	0	0	0	0	0	0	0	0	11196
Construction Supervision	0	0	0	0	0	0	0	0	9797
Column Total	13993	2200	352	3505	1369	7200	10800	1052	160948
	11	12	13	14	15	16	17	18	19

Standard Unit Project D2 Suburban Parking Lot Construction, 100 Spaces	Total	Administration		Labour		Equipment				Non-Met. Minerals
		Overhead	Profit	Wages	Fringe	Fuel	Repairs	Insurance	Depreci-ation	
task										
Excavation	3500	280	70	1309	196	214	165	33	1234	0
Granular "A"	6600	528	132	2354	352	335	257	51	1931	440
Asphalt Surface	5867	469	117	664	99	76	59	12	440	2229
Illumination	4000	320	80	1044	156	76	60	12	450	0
Miscellaneous	2995	599	150	651	97	97	75	15	562	0
Engineering Design	1837	514	129	1039	155	0	0	0	0	0
Construction Supervision	1607	450	113	909	136	0	0	0	0	0
Column Total	26406	3161	790	7970	1191	800	615	123	4616	2669
	1	2	3	4	5	6	7	8	9	10

SUP D2 (continued)	Non-Met. Mineral Products	Petroleum & Coal Products	Tax	Primary Metal Products	Chemicals Chemical Products	Electrical & Comm Products	Metal Fabricated Products	Trans-port	Total
Excavation	0	0	0	0	0	0	0	0	3500
Granular "A"	0	0	0	0	0	0	0	220	6600
Asphalt Surface	0	1467	235	0	0	0	0	0	5867
Illumination	0	0	0	0	0	720	1080	0	4000
Miscellaneous	374	0	0	150	225	0	0	0	2995
Engineering Design	0	0	0	0	0	0	0	0	1837
Construction Supervision	0	0	0	0	0	0	0	0	1607
Column Total	374	1467	235	150	225	720	1080	220	26406
	11	12	13	14	15	16	17	18	19

Standard Unit Project E1
Municipal Transportation Centre

task	Total	Administration		Labour		Equipment				Non-Met. Minerals	Non-Met. Mineral Products
		Overhead	Profit	Wages	Fringe	Fuel	Repairs	Insurance	Depreciation		
General Allowance	515000	51500	51500	67950	15450	300	5150	4600	5150	21800	13200
General Requirements	672550	432780	27220	132793	37720	3031	1500	0	10654	0	0
Sitework	2830685	280765	280765	466498	90281	70809	41998	42358	164675	468982	228940
Concrete Work	2426550	242655	242655	608919	132289	24221	0	36276	68228	0	451632
Masonry	1693620	169362	169362	722151	33872	33872	0	33872	0	0	480319
Metals	1818040	181804	181804	480611	89345	0	5801	11601	72722	0	0
Carpentry	155450	15545	15545	65873	4664	0	0	0	6218	0	400
Thermal & Moisture Proofing	829590	82959	82959	186164	17445	12951	0	12951	33274	45329	19947
Windows & Doors	698120	69812	69812	104826	13962	0	0	3890	28256	0	82117
Finishes	843730	84373	84373	174936	34781	155	361	103	24954	0	158098
Specialties	75100	7510	7510	15020	3004	0	0	0	3755	0	544
Equipment	755900	75590	75590	151180	30236	0	0	0	37795	0	24180
Conveying Systems	77200	7720	7720	15440	3088	0	0	2316	3860	0	0
Mechanical	2676000	279500	267600	714650	142930	0	0	25460	66420	153340	22440
Electrical	1345000	144900	134500	328700	79460	0	0	15700	57140	5000	0
Labour Burden	96327	0	0	77062	19265	0	0	0	0	0	0
Fee & Overhead	875443	486676	388767	0	0	0	0	0	0	0	0
Column Total	18384305	2613450	2087682	4312773	747793	145340	54810	189128	583100	694451	1481818
	1	2	3	4	5	6	7	8	9	10	11

SUP E1 (continued)

	Petroleum & Coal Products	Tax	Primary Metal Products	Chemicals Chemical Products	Electrical & Comm Products	Plastic Fabricated Products	Transport	Metal Fabricated Products	Lumber, Wood Products	Agric. & Forestry Products	Total
General Allowance	9020	58620	30800	26510	22550	22550	25300	37950	22550	22550	515000
General Requirements	0	8792	564	1266	14122	0	1548	0	560	0	672550
Sitework	0	24815	251845	0	0	0	339811	45716	0	32428	2830685
Concrete Work	12955	67065	0	0	0	0	72797	333659	133200	0	2426550
Masonry	0	0	0	0	0	0	50809	0	0	0	1693620
Metals	0	19737	0	0	0	0	32895	741720	0	0	1818040
Carpentry	0	4664	200	0	0	2650	7773	900	31020	0	155450
Thermal & Moisture Proofing	176795	24888	0	62229	3000	150	41480	9060	0	15012	829590
Windows & Doors	0	20944	0	0	27000	29700	34906	212895	0	0	698120
Finishes	38360	59061	0	20844	0	66060	40277	56991	0	0	843730
Specialties	0	5257	0	380	665	2724	3755	24436	540	0	75100
Equipment	6830	52913	0	6575	40625	15021	37795	199690	1680	0	755900
Conveying Systems	0	5404	0	0	11580	3000	3860	13212	0	0	77200
Mechanical	3000	149010	0	0	108140	0	132950	610560	0	0	2676000
Electrical	0	93600	0	0	419750	0	66250	0	0	0	1345000
Labour Burden	0	0	0	0	0	0	0	0	0	0	96327
Fee & Overhead	0	0	0	0	0	0	0	0	0	0	875443
Column Total	249960	594768	283409	117804	647632	141855	892204	2286789	189550	69990	18384305
	12	13	14	15	16	17	18	19	20	21	22

4/ Economic Impacts of Transportation Projects and Programs in Ontario

This chapter is intended to illustrate the use of TRIM for the analysis of projects and programs. As discussed in Chapter 2, such analysis focuses on the economic impacts of a project or program initiative on the total Ontario economy. It takes account of inter-industry demands and feedbacks and of the effect on consumer spending.

The analysis will show that expenditures by MTO on Municipal Roads, Airports, Provincial Highways and Municipal and Provincial Transit generate significant income and employment effects in Ontario. It will also show the relative impacts of the various projects. This is of interest because one wants to know the comparative efficiency of different projects, as alternative contenders for government expenditures, in terms of their effects on output, jobs, tax revenue and energy conservation. If competing projects can satisfy primary needs with equal effectiveness, differential secondary impacts can enter the project selection decision.

The illustrations will also show that MTO projects involve substantial amounts of energy use and that dependence on oil is large. Because Ontario depends so strongly on energy brought in from outside its borders there is a special interest in monitoring its use. While taking account of it for capital projects is not considered very important under present energy market conditions, energy shortages and rising prices will undoubtedly recur. Having the capability to compare capital projects in terms of energy use is, therefore, still very important.

As with the other impacts, the analysis that follows suggests only very briefly how energy accounting can be brought to bear on MTO planning. Because development of the computer model and the data contained in it required so much effort, the scope of this report is somewhat limited: a full exposition of how TRIM's impact indicators can be used was not possible. Presumably the Ministry will be interested in exploring its potential more fully at the implementation stage and beyond. For the moment what follows in this chapter presents an introductory picture of the interpretation of impact indicators.

Four different types of illustrations are set out:

1) Four individual standard unit projects are analysed.
2) The scale of a standard unit project is adjusted. Illustrative projects are scaled upwards by choosing a larger physical size and allowing the dollar value to adjust proportionally, and by choosing a dollar expenditure level, allowing the number of project units to increase.

3) An expenditure program involving a group of scaled projects is illustrated.
4) An illustration of how MTO's annual program expenditures can be analysed with TRIM is presented.

To understand the nature of the illustrations the reader may wish to refer back to the project descriptions in Chapter 3 and, especially, to the cost tables in Appendix 3A.

It is important to remember that all of the illustrations that follow are constructed by applying the basic assumptions of input-output analysis. This means, among other things, that the illustrations assume a sufficient amount of unemployed resources in Ontario, and in import-supplying industries outside of Ontario, to produce all of the extra output generated by the simulated projects. They also assume that the projects are small enough not to bring about any changes in the input-output structure of the economy. Recall as well that the underlying data are based on the structure of the economy as it was in 1979. All values are, however, adjusted to reflect price changes between 1979 and the present.

4.1/ Individual Projects

4.1.1/ Municipal Roads: Four-Lane Collector/Arterial Road Reconstruction

The TRIM print-out for Municipal Roads SUP A3 is shown in Table 4.1. An initial expenditure of $137 600 to reconstruct 100 m of a four-lane arterial municipal road generates a total increment to Ontario income (GDP) of $192 400 when the indirect and induced effects are added on. This can be described as a multiplier effect of 1.40. The employment multiplier is significantly higher than the income multiplier; 1.5 initial direct jobs are magnified into 5.1 jobs when the total impact of the project expenditures is tallied. The sectors that produce inputs for municipal road construction (the Indirect impact) and the consumer goods purchased with income generated by the project (the Induced impact) are more labour intensive than the road construction sector itself.[9]

[9]Readers familiar with National Accounting may find it odd to observe that, in the Indirect and Induced column, Labour Income is greater than GDP. This is a result of aggregating Indirect and Induced impacts. The Indirect expenditures are on intermediate goods; since the amounts shown for Gross Domestic Product can be measured as expenditures on final products, these intermediate goods do not contribute to the top entry in the second column (their value is included in the top entry of the first column). The intermediate goods do, however, generate Gross Sales and Labour Income. Thus the GDP in the second column is due only to the Induced Expenditure, while Labour Income is the sum of income generated by both the Indirect and the Induced Expenditure.

Table 4.1/ Municipal Roads: Four-Lane Collector/Arterial Road Reconstruction

Provincial Impact
(dollars)

	Initial	Indirect & Induced	Total
Gross Domestic Product	137 647	54 713	192 360
Gross Sales	93 409	180 287	273 696
Labour Income	38 026	74 596	112 622
Employment (Person-Years)	1.5	3.6	5.1
Initial Expenditure			137 647

Tax Revenue
(dollars)

	Federal	Provincial	Local	Total
Personal Tax	13 270	6 245	0	19 515
Indirect Business Tax	4 921	7 913	0	12 834
Tariffs	2 894	0	0	2 894
Corporate Profit Tax	3 982	1 961	0	5 944
Property & Business Tax	0	0	6 850	6 850
Total Taxes	25 068	16 119	6 850	48 037

Imports
(dollars)

Imports from Other Provinces	33 567
Imports from Outside Canada	32 475
Total Imports	66 041

Energy

Physical Units

Coal	0.0	Kilotonnes
Crude Oil	0.2	Megalitres
Natural Gas	0.0	Gigalitres
Electricity	0.1	Gigawatt-Hours

Energy Units

Coal	0.8	Terajoules
Crude Oil	6.5	Terajoules
Natural Gas	1.5	Terajoules
Electricity	0.4	Terajoules
Liq. Pet. Gases & Nuc. Steam	0.1	Terajoules
Total Energy	9.2	Terajoules

The creation of income and gross output (sales) needed to sustain municipal road construction gives rise to tax recoveries, indicating that the net cost to the provincial government of a municipal road project is significantly less than the initial cost. In this case a total of $16 119 is recovered by the provincial government from sales, income and corporate taxes. The federal government collects a larger amount, over $25 000, while local governments recover $6 850. Total tax recoveries add up to $48 037, about 35% of the original cost of the project.

Economic impacts associated with this project are not restricted to Ontario; other provinces experience an increase in demand for their products to the tune of $33 567. A slightly smaller amount flows outside Canada. Total imports associated with this project amount to $66 041. In other words, about 24% of the total sales generated by expenditures on 100 m of four-lane municipal road are obtained from outside Ontario.

Finally, Table 4.1 shows primary energy consumption associated with the initial, indirect and induced effects of the project. The use of crude oil accounts for the largest portion of energy use, amounting to 71% of the total energy units. This reflects the fact that, in addition to the petroleum-based fuels used in construction and in the manufacture and delivery of intermediate goods, asphalt and related materials are used on the road itself. In general transportation projects, especially those involving pavement, depend heavily on oil-based energy. This is evident for all of the SUPs; nevertheless the "oil intensity" of energy use is seen to vary across different types of projects.

4.1.2/ Airports: Major Upgrade of a 3 500 ft Runway

Table 4.2 shows the results of running SUP B2 in the Municipal Airports group, a financially larger project. A $2.1-million initial expenditure on upgrading a 3500 ft runway generates $3 million of total income in Ontario, implying a multiplier of 1.44. Employment associated with the initial expenditure is 23.4 person-years and the employment multiplier in this case is 3.5. While the airport project creates more jobs because it involves a larger initial expenditure, it is similar to the above road project in its job creating potential. This is seen, for instance, by dividing the number of jobs into GDP for each project: on average, in the airport project 1 job is created for every $25 602 of new spending; in the municipal road project 1 job is created for every $26 990 of new spending.

Table 4.2/ Municipal Airports: Major Upgrade of a 3 500 ft Runway

Provincial Impact
(dollars)

	Initial	Indirect & Induced	Total
Gross Domestic Product	2 096 795	915 934	3 012 729
Gross Sales	1 435 130	2 920 066	4 355 196
Labour Income	587 469	1 226 424	1 813 894
Employment (Person-Years)	23.4	58.5	81.9
Initial Expenditure			2 096 795

Tax Revenue
(dollars)

	Federal	Provincial	Local	Total
Personal Tax	213 726	100 577	0	314 303
Indirect Business Tax	73 324	117 906	0	191 230
Tariffs	47 709	0	0	47 709
Corporate Profit Tax	64 735	1 884	0	96 619
Property & Business Tax	0	0	102 067	102 067
Total Taxes	399 495	250 367	102 067	751 929

Imports
(dollars)

Imports from Other Provinces	503 919
Imports from Outside Canada	514 556
Total Imports	1 018 474

Energy

Physical Units

Coal	0.4	Kilotonnes
Crude Oil	2.0	Megalitres
Natural Gas	0.5	Gigalitres
Electricity	1.9	Gigawatt-Hours

Energy Units

Coal	11.9	Terajoules
Crude Oil	78.5	Terajoules
Natural Gas	23.9	Terajoules
Electricity	6.9	Terajoules
Liq. Pet. Gases & Nuc. Steam	0.8	Terajoules
Total Energy	122.0	Terajoules

The government's net cost is lower than the initial cost due to tax recoveries made by the three levels of government. More than 35% of the total cost of the project is recovered from indirect business taxes, personal taxes, corporate profit taxes, tariffs, and local property and business taxes. The federal government collects the largest portion, almost $400 000; the Ontario government collects about $250 000.

Other provinces share to some extent in the generated economic gains. However, again foreign producers supply more of the imported inputs than the other Canadian provinces combined.

Energy use in upgrading a runway is slightly more evenly spread than in municipal road construction. Crude oil accounts for 64% of total energy use in this case, while it accounted for 71% in the preceding one. On average the road project uses more crude oil per dollar of construction cost than the airport project; crude oil consumed 1.45 litres/$ and 0.95 litres/$ of initial expenditure in the municipal road and airport examples respectively.

4.1.3/ Provincial Highways: Reconstruction of a Two-Lane Paved Road

Table 4.3 shows TRIM's results for Provincial Highway SUP C3, the reconstruction of 1 km of a two-lane paved road. The initial expenditure of $297 000 produces total GDP of $422 000. The resulting multiplier of 1.42 is very close to the corresponding multiplier for the municipal road construction illustration (Table 4.1), 1.40. The two projects are also similar in terms of their employment creation: in the Municipal Road project it takes $26 990 of initial expenditure to generate each person-year of work (based on the total employment of 5.1 person-years); in the Provincial Highway project the corresponding expenditure is slightly lower at $25 145. While one would expect road building to have similar impacts in both situations, it is interesting to see that expectation verified because the municipal road cost data and the highway cost data contained in TRIM were originally constructed in different ways. The municipal data (and data on all of the other non-highway projects) were collected by the TRIM research team; the highway data are adapted from MTO's earlier MIES project.

Labour income generated by this project is shown as $117 093 for the project itself and $136 213 for the Indirect and Induced expenditures associated with the project. Using the Employment numbers in Table 4.3 to calculate labour income per worker, this works out to $24 913 per job for the Initial Expenditure and $19 186 per job for the Indirect and Induced Expenditure. The model indicates that work on highway building involves a higher average wage than that earned in producing the intermediate goods demanded for the project and in producing the consumer goods accounted for by induced expenditure.

Table 4.3/ Provincial Highways: Reconstruction – Paved, Two Lanes

Provincial Impact
(dollars)

	Initial	Indirect & Induced	Total
Gross Domestic Product	296 714	125 543	422 257
Gross Sales	159 043	380 490	539 533
Labour Income	117 093	136 213	253 306
Employment (Person-Years)	4.7	7.1	11.8
Initial Expenditure			296 714

Tax Revenue
(dollars)

	Federal	Provincial	Local	Total
Personal Tax	29 846	14 045	0	43 892
Indirect Business Tax	10 196	16 395	0	26 591
Tariffs	6 410	0	0	6 410
Corporate Profit Tax	9 299	4 580	0	13 879
Property & Business Tax	0	0	14 193	14 193
Total Taxes	55 752	35 020	14 193	104 965

Imports
(dollars)

Imports from Other Provinces	79 950
Imports from Outside Canada	73 446
Total Imports	153 396

Energy

Physical Units

Coal	0.0	Kilotonnes
Crude Oil	0.5	Megalitres
Natural Gas	0.1	Gigalitres
Electricity	0.2	Gigawatt-Hours

Energy Units

Coal	1.3	Terajoules
Crude Oil	20.5	Terajoules
Natural Gas	3.0	Terajoules
Electricity	0.8	Terajoules
Liq. Pet. Gases & Nuc. Steam	0.1	Terajoules
Total Energy	25.8	Terajoules

Imports from outside the province for the highway reconstruction project amount to $153 396. This is 28.4% of Total Gross Sales, a somewhat larger percentage than for the municipal road project (24.1%). Total energy use on the project amounts to 25.8 tJ, with crude oil accounting for 79% of the total in this case.

4.1.4/ Municipal Transit: Municipal Transportation Centre

The single SUP currently included in the Municipal Transit category involves a very large expenditure ($18.4 million) relative to the above projects. (It could be broken down into sub-projects, but it is useful to have it in the TRIM database to illustrate that the program can handle large composite efforts.) Employment directly associated with building the Centre is 202 person-years, while 462 year-long jobs are associated with the indirect and induced production that results from the initial expenditure. Thus the total employment multiplier in this case is 3.29, with 1 person-year of work resulting from every $27 679 of initial expenditure on the Transportation Centre.

An initial cost of $18 384 306 results in a total tax recovery of almost $6 942 948. The Provincial government recovers 34% of this, local governments 14%. Total Imports from outside Ontario amount to $7.7 million, or 42% of the initial expenditure. This is considerably less than the municipal road project (48%) or the airport project (49%).

The magnitude of the project shows up again in energy use, with total consumption equal to 752 tJ. Since this project does not involve road pavement, the proportion of total energy used from crude oil is lower, at 53%, than for projects discussed previously.

Table 4.4/ Municipal Transit: Municipal Transportation Centre

Provincial Impact
(dollars)

	Initial	Indirect & Induced	Total
Gross Domestic Product	18 384 306	7 988 305	26 372 611
Gross Sales	10 641 290	23 584 590	34 225 880
Labour Income	5 060 566	9 539 053	14 599 619
Employment (Person-Years)	201.8	462.3	664.2
Initial Expenditure			18 384 306

Tax Revenue
(dollars)

	Federal	Provincial	Local	Total
Personal Tax	1 720 233	809 521	0	2 529 754
Indirect Business Tax	713 203	1 146 831	0	1 860 034
Tariffs	378 703	0	0	378 703
Corporate Profit Tax	791 725	389 954	0	1 181 680
Property & Business Tax	0	0	992 779	992 779
Total Taxes	3 603 864	2 346 307	992 779	6 942 950

Imports
(dollars)

Imports from Other Provinces	3 842 287
Imports from Outside Canada	3 862 440
Total Imports	7 704 727

Energy

Physical Units

Coal	3.6	Kilotonnes
Crude Oil	10.3	Megalitres
Natural Gas	3.7	Gigalitres
Electricity	14.2	Gigawatt-Hours

Energy Units

Coal	108.0	Terajoules
Crude Oil	398.2	Terajoules
Natural Gas	188.2	Terajoules
Electricity	51.1	Terajoules
Liq. Pet. Gases & Nuc. Steam	6.7	Terajoules
Total Energy	752.1	Terajoules

4.2/ Scale Adjustments

Often TRIM users will want to know the values of economic impacts for a given type of project contained in the database but of a different physical size and/or for a given dollar amount of expenditure. Both types of scaling can be done with TRIM, but the accuracy of the results depend on how the scaling is done.

The model's calculations are most accurate when the input data have been constructed specifically for the project size being considered. As an illustration consider scaling up SUP A4 of the Municipal Roads group (the reconstruction of a two-lane collector/arterial road) from the 100 m in the database to 1 km. If the costs of doing this type of construction were all of the variable type, multiplying every input cost by a factor of 10 would result in a project simulation as accurate as the original SUP. However, this is not the case; some of the costs of building a piece of road are fixed over a considerable range of lengths, some of them will vary proportionally over length, some of them will vary, but less than proportionally. For this reason the only way to obtain a fully accurate scaling, consistent with the assumptions of the model, is by going to the table of input costs for the project (in Appendix 3A), adjusting the costs on each "task line", and changing the column totals. These new totals would then be entered into the menu of costs by commodity group when the project is run through TRIM.[10]

An alternative is simply to set the Scaling Factor in the program to 10.0, instead of its default value of 1.0, when SUP A4 is chosen from the standard Municipal Roads menu. This has been done for the run shown in Table 4.5. It is as accurate as the unadjusted SUP if it is interpreted as 10 construction projects each 100 m long. It can also be viewed as a rough approximation of a specially costed project. The greater the difference in size between the scaled project and the standard unit project, the less accurate such an approximation is. Recall as well, as noted in Section 3.4, that projects scaled upward retain more accuracy than those scaled downward.

In general, the presence of fixed costs in any project means that rescaling will introduce error. Providing estimates of the magnitude of error and/or building a more complex model that contains adjustment factors to account for the effects of fixed costs, are options to be considered, but were beyond the scope of the present project.

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[10]This could be done either by creating your own TRIM project or by taking the option to adjust input costs for Municipal Roads SUP 4 at the beginning of the project run.

A second way of scaling a project is in terms of a specified dollar expenditure. Table 4.6 shows the impacts associated with spending $1 million on resurfacing two-lane provincial highways (SUP C5 of the Provincial Highway projects). If this option is chosen the program divides the total cost of the standard unit project ($57 989) into $1 million and scales by the result (17.2). Again, these results would be more accurate if they were to apply to 17 resurfacing sub-projects than if they are meant to apply to 1.72 km of continuous resurfacing. Table 4.6 shows that the $1 million results in approximately 10 direct jobs and 30 in total.

Table 4.5/ Municipal Roads – Scaling Illustration: Two-Lane Collector/Arterial Road Reconstruction

Provincial Impact
(dollars)

	Initial	Indirect & Induced	Total
Gross Domestic Product	956 449	402 636	1 359 085
Gross Sales	631 898	1 274 246	1 906 144
Labour Income	281 683	518 289	799 972
Employment (Person-Years)	11.2	25.1	36.4
Initial Expenditure			956 449

Tax Revenue
(dollars)

	Federal	Provincial	Local	Total
Personal Tax	94 259	44 357	0	138 615
Indirect Business Tax	34 308	55 168	0	89 476
Tariffs	20 660	0	0	20 660
Corporate Profit Tax	28 107	13 844	0	41 950
Property & Business Tax	0	0	47 757	47 757
Total Taxes	177 333	113 368	47 757	338 458

Imports
(dollars)

Imports from Other Provinces	230 666
Imports from Outside Canada	226 711
Total Imports	457 377

Energy

Physical Units

Coal	0.2	Kilotonnes
Crude Oil	1.0	Megalitres
Natural Gas	0.2	Gigalitres
Electricity	0.8	Gigawatt-Hours

Energy Units

Coal	5.6	Terajoules
Crude Oil	40.3	Terajoules
Natural Gas	10.4	Terajoules
Electricity	3.0	Terajoules
Liq. Pet. Gases & Nuc. Steam	0.4	Terajoules
Total Energy	59.6	Terajoules

Table 4.6/ Provincial Highways – Dollar Scaling Illustration: Resurfacing, Two Lanes

Provincial Impact
(dollars)

	Initial	Indirect & Induced	Total
Gross Domestic Product	1 000 000	120 024	1 120 024
Gross Sales	675 994	1 040 914	1 716 908
Labour Income	255 990	384 462	640 451
Employment (Person-Years)	10.2	19.9	30.1
Initial Expenditure			1 000 000

Tax Revenue
(dollars)

	Federal	Provincial	Local	Total
Personal Tax	75 463	35 512	0	110 975
Indirect Business Tax	27 690	44 524	0	72 213
Tariffs	16 892	0	0	16 892
Corporate Profit Tax	27 157	13 376	0	40 533
Property & Business Tax	0	0	38 543	38 543
Total Taxes	147 201	93 412	38 543	279 157

Imports
(dollars)

Imports from Other Provinces	319 262
Imports from Outside Canada	261 994
Total Imports	581 256

Energy

Physical Units

Coal	0.1	Kilotonnes
Crude Oil	3.4	Megalitres
Natural Gas	0.2	Gigalitres
Electricity	0.7	Gigawatt-Hours

Energy Units

Coal	3.8	Terajoules
Crude Oil	130.7	Terajoules
Natural Gas	8.8	Terajoules
Electricity	2.5	Terajoules
Liq. Pet. Gases & Nuc. Steam	0.5	Terajoules
Total Energy	146.3	Terajoules

4.3/ Program Analysis: Combinations of Projects

TRIM is capable of assigning impact values to combinations of projects in a very efficient manner. After a SUP is selected from the menu provided by the program, the option of choosing an additional one, before the calculations are done, is provided. The input costs for the collection of selected SUPs are then cumulated. Note that each SUP in a combination can be individually scaled as described above.

The example chosen here is an airport development program, involving four projects:

1) a minor upgrade of an existing 5000 ft runway (Airport SUP B9),
2) an airport access road 200 m long (Airport SUP B10),
3) a two-lane municipal arterial road 2 km long (Municipal Road SUP A4 scaled up by a factor of 20), and
4) a short-span two-lane bridge over water (Municipal Road SUP A9).

As shown in Table 4.7, the development program costs about $3.6 million, with a total GDP impact of about $5.1 million. It involves about 40 direct jobs and 136 in total. As a result of the program $1.3 million of tax revenue is collected.

4.4/ Program Analysis: Ministry Budgets

TRIM can be used in many different ways to analyse program budgets. Here only a simple illustration is provided.

The Ontario Public Accounts report that the Ministry of Transportation spent over $540 million in its Provincial Highways program in 1985/86, with about $292 million allocated to Capital and Construction.

Table 4.7/ Airport Redevelopment Program: Multiple Projects

Provincial Impact
(dollars)

	Initial	Indirect & Induced	Total
Gross Domestic Product	3 595 370	1 459 372	5 054 742
Gross Sales	2 446 031	4 808 916	7 254 946
Labour Income	997 396	1 990 104	2 987 499
Employment (Person-Years)	39.8	95.8	135.5
Initial Expenditure			3 595 370

Tax Revenue
(dollars)

	Federal	Provincial	Local	Total
Personal Tax	352 009	165 651	0	517 660
Indirect Business Tax	128 017	205 851	0	333 867
Tariffs	77 133	0	0	77 133
Corporate Profit Tax	106 001	52 210	0	158 211
Property & Business Tax	0	0	178 199	178 199
Total Taxes	663 159	423 711	178 199	1 265 070

Imports
(dollars)

Imports from Other Provinces	882 086
Imports from Outside Canada	858 374
Total Imports	1 740 460

Energy

Physical Units

Coal	0.7	Kilotonnes
Crude Oil	4.2	Megalitres
Natural Gas	0.8	Gigalitres
Electricity	3.2	Gigawatt-Hours

Energy Units

Coal	20.9	Terajoules
Crude Oil	163.4	Terajoules
Natural Gas	39.6	Terajoules
Electricity	11.5	Terajoules
Liq. Pet. Gases & Nuc. Steam	1.4	Terajoules
Total Energy	236.8	Terajoules

If the distribution of this total budget over projects were known and TRIM cost data were available for all of the project types,[11] one could use the expenditure on each project as a scaling coefficient and the overall impacts of the Capital and Construction budget could be simulated. For example, if $1 million were to be allocated to a four-lane highway that costs $370 658/km (Provincial Highway SUP C1), the $1-million figure is entered in response to the prompt for the scaling option and TRIM would automatically increase the size of the project by 2.7 (i.e. with the assumed budget 2.7 km of highway can be built). In this way, a combination of projects would be defined, with each project in the budget scaled by its expenditure. As a very simple illustration for this report, it was assumed that the Ministry spent equal proportions of its Highway Capital and Construction program on each of the 10 Provincial Highway SUPs in the present version of the TRIM database.

The results of feeding the combination of SUPs so defined through TRIM are shown in Table 4.8. In this example one sees that the highway construction program can be associated with about $372 million of initial, indirect and induced GDP, 10 068 person-years of work, and $94 million of tax recovery spread across all levels of government.

Such an application of TRIM clearly has to be thought of differently from one referring to a small project. Input-output analysis is most accurate when applied to small increments of spending in a situation in which excess resource capacity is available. It is not appropriate to interpret the above figures as if they reflect accurately what a total increase of nearly $300 million in highway expenditure would do in the Ontario economy. That would stretch the capacity of the highway construction sector beyond what it could produce: bottlenecks would occur and input prices rise. In short, the input-output structure of the economy would change and the underlying data of the model would have to change accordingly. A sensible way to interpret Table 4.8 is simply as an illustration of how rough orders of magnitude of the impacts associated with the Highways capital program can be obtained from the model.

An alternative way to use the model to analyse program expenditures is to recognize that an average annual expenditure in the Highways program is a normal part of the Ontario economy. Thus it would be more appropriate to use the expected increase or decrease in the types of projects represented in TRIM as the starting point for a program impact analysis.

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[11] Many projects in the budget could be simulated by SUPS in the current database. Adjusted SUPs and specially defined datafiles could be prepared for the remainder. The latter could, of course, involve a lot of effort. In the version of TRIM that will ultimately be used by Ministry staff there will presumably be enough SUPs defined to allow rough simulations of all projects without the preparation of special new datafiles.

Table 4.8/ Ministry Capital & Construction Program 1985/86: Provincial Highways

Provincial Impact
(millions of dollars)

	Initial	Indirect & Induced	Total
Gross Domestic Product	292	80	372
Gross Sales	192	356	548
Labour Income	78	136	214
Employment (Person-Years)	3 118.9	6 948.6	10 067.5
Initial Expenditure			292

Tax Revenue
(millions of dollars)

	Federal	Provincial	Local	Total
Personal Tax	25	12	0	37
Indirect Business Tax	9	15	0	24
Tariffs	6	0	0	6
Corporate Profit Tax	9	5	0	14
Property & Business Tax	0	0	13	13
Total Taxes	50	31	13	94

Imports
(millions of dollars)

Imports from Other Provinces	80
Imports from Outside Canada	73
Total Imports	153

Energy

Physical Units

Coal	55.9	Kilotonnes
Crude Oil	583.3	Megalitres
Natural Gas	59.1	Gigalitres
Electricity	231.6	Gigawatt-Hours

Energy Units

Coal	1 670.7	Terajoules
Crude Oil	22 459.1	Terajoules
Natural Gas	3 011.4	Terajoules
Electricity	833.7	Terajoules
Liq. Pet. Gases & Nuc. Steam	140.6	Terajoules
Total Energy	28 115.5	Terajoules

5/ Concluding Comments

This project has been concerned with the development of economic stimulation and energy indicators for the evaluation of capital investment initiatives in various transportation modes; it is a response to the Research Needs on that subject set out in the 1986/87 Ontario Joint Transportation and Communications Research Program. The Transport Impact Model described in this report provides a set of indicators, defined within the framework of input-output accounting, that will satisfy the Ministry's requirements. Ministry staff will now be able to use TRIM to calculate the economic impacts of capital project expenditures in terms of numerous variables of interest to transportation decision-makers.

Defined specifically for the Ontario economy, the major impact variables are Labour Income, Gross Domestic Product, Employment, Gross Sales, Tax Revenue, Imports from other provinces and abroad, and Primary Energy Consumed. Some of these variables are further separated into major components; for example, Tax Revenue is broken down into Federal, Provincial and Local components and into the revenues associated with different types of taxes. For each impact indicator, TRIM shows the initial effect of a capital expenditure and the indirect and induced effects of it.

In addition to providing estimates of the economic impacts of capital expenditures, the Transport Impact Model can be viewed as an aid to analysis and communication that, for various reasons, will enhance the Ministry's planning process. It will, for instance, lead staff in various parts of the Ministry to communicate reports and opinions on project planning in a common framework and to focus on a common set of variables which are mutually understood. Furthermore, it is likely to help Ministry staff to develop consistent techniques of cost analysis. Our research team has collected a large amount of detailed engineering and cost data, organized it in a consistent manner and inserted it into TRIM as 35 standard unit projects. Users of the model who become familiar with this database will learn how to analyse project costs in a way that allows their secondary impacts to be calculated.

While TRIM is a working model as it stands, in its present form it should be viewed as a starting point for the Ministry's use of economic impact analysis. There is scope for much further development, both in terms of the model itself and in terms of how it is used in the Ministry. It is useful to close this report with a number of recommendations. After a period of extensive work on this project the McMaster research team is currently in a position to see clearly the potential returns from additional effort, both by the Ministry staff and by outside experts.

5.1/ Recommendations

5.1.1/ Customizing and Using TRIM

Because some users will be unfamiliar with the methodology used in TRIM, and in some cases unfamiliar with the use of interactive programs, Ministry staff will have to undergo learning process. Furthermore, it is always possible to make a computer program more efficient and understandable after some experience with its use has been observed. TRIM is already a user-friendly program, but it could be made more so for users at the Ministry by developing it to take account of normal work practices and special needs so far unknown to the research team. Finally, there are some facilities that can easily be handled by TRIM that have not yet been built into it. (i.e. although users will see a prompt for the graphing of calculated impacts, it was not possible to build that facility into the program in the short time so far available.) For these reasons, the Ministry should consider carrying out an implementation program for TRIM.

5.1.2/ Maintaining TRIM

To remain useful, an economic impact model should be regularly updated. As noted in Appendix A, there is a considerable lag in the publication of input-output data by Statistics Canada. The input-output structure of TRIM is based on the latest data available for the Province of Ontario, those which apply to 1979. The next update of the provincial input-output tables, which will apply to 1984, is likely to appear in 1988 or 1989. When that happens, the Ministry should update TRIM to account for structural changes in the Ontario economy between 1979 and 1984.

The parameters of the model also depend on the prices of goods and services. As inflation occurs, and as the prices of goods and services important in the construction of transportation facilities change relative to each other and to other goods' prices, the existing model will produce outdated calculations. The Ministry should update TRIM on a regular basis to account for price changes.

5.1.3/ Improving TRIM

As the reader of this report and the user of the model will realize, an input-output based computer program involves literally hundreds of decisions regarding the source and use of data and the method of calculation. In the initial development of such a complex model it is inevitable that some aspects of its structure will involve arbitrary assumptions and/or assumptions necessarily made for pragmatic reasons. After a period of use of the model it may be possible to improve it by adjusting some of these assumptions. After gaining experience with TRIM, the Ministry should consider a

comprehensive review of it with a view to customizing the underlying model to the Ministry's specific needs.

Ministry staff will soon discover what aspects of the model are most useful to them. In this regard it will be interesting to find whether users depend most often on the standard unit projects contained in the database, whether they very often make special adjustment to the SUPs, or whether they very often construct their own simulated projects. The set of 35 SUPs contained in TRIM is considerably more extensive than the one originally conceived when the project was being planned in consultation with Ministry personnel. There is, however, scope for expanding the number and variety of standard unit projects in the database. Our research team has developed considerable experience in gathering information for this purpose and we believe that the data so developed are of high quality. If users tend to depend on the standard unit projects contained in the database, the Ministry should consider expanding their number.

At minimum we suggest that SUPs be added in those few areas in which the data collection process was begun but could not be completed in time for this report. This is possible, for instance, in the case of Municipal Transit, where the Toronto Transit Commission is willing to aid us in developing typical rapid transit projects. As noted in Chapter 3, it may also be desirable to develop additional SUPs in relation to the activities of GO Transit and to investigate more deeply the relation between the Provincial Highway data (put together by the Ministry in connection with the MIES project) and the rest of the data in the TRIM database. The Ministry should consider expanding the standard unit project database provided with the current present version of TRIM. If users tend to develop their own simulated typical projects, the Ministry should consider how to develop expertise within the Ministry in regard to data collection specifically appropriate for the Transport Impact Model.

5.1.4/ Developing Related Applications

In its present version TRIM focuses entirely on the secondary impacts of the Ministry's expenditure programs. The Ministry is also interested in the development of indicators which capture the primary effects of transportation investment initiatives in Ontario: i.e. it wants to have indicators of the direct value to the people of Ontario of transportation services generated by the Ministry expenditures. Such indicators should be developed within an internally consistent framework, applicable across the various transportation modes. When they are developed it will be useful to integrate them into the framework used for secondary impact indicators. In fact, it may be possible to integrate primary impact calculations into the TRIM framework. Thus we recommend that the

Ministry consider linking its development of primary social impact indicators with its program of secondary impact assessment.

Finally, the underlying framework of the Transport Impact Model, involving cost accounting, input-output analysis and matrix mathematics, is a very powerful tool in relation to a range of analytical questions. Calculations involving large amounts of cost data, price adjustments, estimating functions and numerous related matters can be efficiently done in this framework. This suggests that there may exist activities within the Ministry, other than the overall planning functions for which TRIM was conceived, that could be made more efficient with a special adaptation of the program underlying the present model. We recommend that the Ministry consider other areas in which the TRIM methodology may be used.

Appendix A/ The Transport Impact Model

The calculation of impact indicators for capital expenditure projects in TRIM is based on the latest input-output table for Ontario available from Statistics Canada (1979). Statistics Canada will not release its next update of provincial tables, which will be for 1984, until sometime in 1988 or 1989. The capital spending projects to be evaluated by TRIM occur in 1986/87 or later and the calculated impacts should refer to the same time period. To deal with this incompatibility between parameters in the model and the value units which measure the input data, all calculations of impacts are done in three stages.

1) Purchased inputs are converted from 1986/87 values to 1979 values.
2) All impacts are calculated in 1979 values.
3) These calculated impacts are converted to 1986/87 values.

Each of these three steps is described in turn.

A.1/ Conversion of Inputs to 1979 Values

This is the simplest part of the model. Each commodity input in 1987 values, $F87_i$, is divided by a corresponding price index, $PI87_i$, (with a 1979 base) in order to convert the input to a 1979 value, $F79_i$.

$$(1)\quad F79_i = F87_i \div PI87_i$$

The labour income input, $W87_f$, must also be converted to a 1979 value, $W79_f$, by dividing by a wage index for construction (industry 21 in the input-output table), $WI87_{21}$.

$$(2)\quad W79_f = W87_f \div WI87_{21}$$

Note that, here and elsewhere in the model where price adjustments are based on published indexes of price changes, a value for 1987 should be understood as one adjusted for price changes up to the end of 1986.

A.2/ Calculation of Impacts in 1979 Values

A.2.1/ Model Description

The impact calculations start with an account of the goods and services to be used in the project. The database of SUPs permits these calculations to be done efficiently. Tables in chapter 3 show the calculation of initial impacts for available SUPs. These inputs embody the initial economic impacts. Based on these initial effects, an input-output model of the Ontario economy is used to calculate the indirect and induced impacts. The following system of relations is the basis of the model. The terms industry and commodity are used as in Statistics Canada's aggregated input-output tables.

- Each industry's output of a commodity is a linear function of gross domestic production of this commodity.

- Each industry use of inputs, such as intermediate goods and services and primary inputs like labor, is a linear function of industry gross output.

- Imports of a commodity are a linear function of the gross domestic production of each commodity.

- Income received by labor is a linear function of the gross domestic outputs of the various industries, as well as of the total household consumption and the initial labor income.

- Household consumption is a linear function of labor income.

Although many additional details must be specified, this set of relations is the basis for the estimation of the indirect and induced effects based on the knowledge of initial impacts. It is augmented by tax structure relations to allow the calculation of tax revenue. In mathematical terms, the system is a set of simultaneous linear equations where the coefficients are defined from the above relations and the right hand side constants are the initial impacts.

A.2.2/ Statistics Canada Input-Output Data Tables

The real process of production and consumption in an open complex economy cannot be described in minute detail. A certain level of aggregation is required before a forest can be seen behind the trees. Products which have similar consumption and production patterns are aggregated to a level of a single commodity (i.e. grains, non-metallic minerals, etc.). Aggregation should be a representation global enough to hide minute details of production and consumption and at the same time fine enough to represent different market structures. Individual production establishments are replaced by the industry. The industry as well should be a global enough representation of a production process to hide the minute details of production and at the same time present a picture in which the major production relations are preserved. Typical examples of the industry in the medium level of aggregation are agriculture, non-metallic mines and quarries etc. Consumers, with their individual tastes and desires are also aggregated to a single consumer with the average propensity to consume.

Statistics Canada develops the Canadian National and Provincial input-output tables as a part of its System of National Accounts. Ontario input-output tables are available in a 43 commodity by 25 industry format. Thus, the Ontario economy is modeled as an open economy in which a total of 43 commodities are produced, used or imported by 25 industries, and consumed by households and government or are exported.

The Statistics Canada input-output tables present national or provincial accounting data in a form of three rectangular matrices: a *make* matrix – **V**; a *use* matrix – **U**; and a *final-demand* matrix – **F**.

The typical element of the make matrix, v_{ij}, is the total production of commodity i by industry j in dollars. The make matrix has as many columns as there are commodities – 43, and as many rows as there are industries – 25. The selected level of aggregation is suitable for the evaluation of impacts of transportation expenditures.

The typical element of the use matrix, u_{ij}, represents the commodity i value used as an intermediate input by industry j. $\Sigma_j u_{ij}$ is the total demand of commodity i by the Ontario economy for production of other goods and services, or intermediate demand. A set of additional rows of the use matrix reflects the demand for primary inputs such as: labour, estimated as labour income; net income of unincorporated business, and other operating surplus; noncompetitive imports; and indirect taxes. These additional rows of the use matrix are organized into a primary-input matrix **Y**. The typical element of **Y**, y_{kj}, represents the value of primary-input k used in industry j. The

primary input and commodity entries describe all the inputs used for production purposes by each industry in the system.

The final-demand matrix, **F**, with typical element f_{is}, defines the deliveries of commodities to the various categories of final demand: consumption, investment, government expenditure, exports to other provinces, exports to the rest of the world, and imports from other provinces and the rest of the world. Primary-input rows of the final-demand matrix are grouped into a matrix, $\mathbf{Y^f}$, with typical elements, y^f_{ks}, which describe the use of each primary input by each final-demand category.

The organization of these matrices and the corresponding row and column totals are shown in Table A1.

Table A1/ Input-Output Data Tables Structure

	Commodities	Industries	Final Demand	Total
Commodities		$u_{11} \ldots u_{1m}$ $u_{21} \ldots u_{2m}$ ... $u_{n1} \ldots u_{nm}$	$f_{11} \ldots f_{1p}$ $f_{21} \ldots f_{2p}$ ... $f_{n1} \ldots f_{np}$	q_1 q_2 q_n
Industries	$v_{11} \ldots v_{1n}$ $v_{21} \ldots v_{2n}$ ... $v_{m1} \ldots v_{mn}$			g_1 g_2 g_m
Primary Inputs		$y_{11} \ldots y_{1k}$ $y_{21} \ldots y_{2k}$ ... $y_{p1} \quad y_{pm}$	$y^f_{11} \ldots y^f_{1t}$ $y^f_{21} \ldots y^f_{2t}$ ... $y^f_{p1} \ldots y^f_{pt}$	$y_1{}^T$ $y_2{}^T$ $y_p{}^T$
Total	$q_1 \ldots q_{1n}$	$g_1 \ldots g_m$	$f_1{}^T \ldots f_t{}^T$	fy^T

The row and column totals, q_i in Table A1, represent the total value of domestic production of each commodity; the totals, g_j, the value of gross domestic output (value of sales) of each industry; the y_k, the total value of each primary input; and the f_s, the total value of each final-demand category.

The following accounting relationships are preserved when the input-output tables are compiled:

Commodity Balances:

$$(3)\quad \Sigma_j u_{ij} + \Sigma_s f_{is} = q_i \qquad i = 1, 2, ..., n$$

The value of intermediate plus final demand for each commodity equals the value of domestic production of the same commodity.

Industry Output:

$$(4)\quad \Sigma_i v_{ji} = g_j \qquad j = 1, 2, ..., m$$

The sum of all the values of commodities produced equals the gross output of each industry.

Commodity-Industry Composition:

$$(5)\quad \Sigma_j v_{ji} = q_i \qquad i = 1, 2, ..., n$$

The sum of the domestic production of commodity i by all industries equals the total domestic production of commodity i.

Input Structure by Industry:

$$(6)\quad \Sigma_i u_{ij} + \Sigma_k y_{kj} = g_j \qquad j = 1, 2, ..., m$$

The sum of intermediate and primary inputs equals the value of gross output of each industry. This follows from the fact that other operating surplus is treated as a residual payment and included in the primary-input matrix **Y**.

Primary Inputs by Type:

$$(7)\quad \Sigma_j y_{kj} + \Sigma_s f_{ks} = y_k^T \qquad k = 1, 2, ..., p$$

The sum of intermediate and final-demand uses of each primary input equals the total use.

Final-Demand Input Structure:

$$(8)\quad \Sigma_i f_{is} + \Sigma_k yf_{ks} = f_s^T \qquad s = 1, 2, \ldots, t$$

The sum of the values of the commodity inputs and primary inputs equals the total value of each final-demand category.

In addition the following two identities can be derived from equations (1) to (6).

Commodity-Industry Totals:

$$(9)\quad \Sigma_i q_i = \Sigma_i \Sigma_j v_{ji} = \Sigma_j \Sigma_i v_{ji} = \Sigma_j g_i$$

The total value of commodity production is equal to the total value of industry gross output.

Final-Demand and Primary-Input Totals:

Since $\Sigma_i(\Sigma_j u_{kj} + \Sigma_s f_{is}) = \Sigma_i q_i$

and $\Sigma_j(\Sigma_j u_{kj} + \Sigma_k y_{kj}) = \Sigma_j g_i$

the equality of commodity and industry totals implies:

$$\Sigma_i(\Sigma_j u_{kj} + \Sigma_s f_{is}) = \Sigma_j(\Sigma_j u_{kj} + \Sigma_k y_{kj})$$

$$(10)\quad \Sigma_k \Sigma_j y_{kj} = \Sigma_s \Sigma_i f_{is}$$

The sum of the value of all primary inputs over all industries is equal to the sum of the value of all commodities used in final demand. Adding primary inputs used in final demand to each side of the above equation we obtain:

$$(11)\quad \Sigma_k y_k^T = \Sigma\Sigma y_{kj} + \Sigma\Sigma yf_{ks} = \Sigma\Sigma f_{is} + \Sigma\Sigma yf_{ks} = \Sigma_s f_s^T$$

The total value of all primary inputs equals the total value of all final demands.

A.2.3/ The Mathematical Structure of the Input-Output Model

The input-output data system describes the structure of the Ontario economy as represented by total flows of goods and primary inputs over a given year. To develop a model of the Ontario economy, assumptions are made to fix the structural parameters of production and consumption. These parameters can be obtained from the input-output data and presented as the ratios of the various matrix elements to row or column totals. The set of structural assumptions made to develop the Transport Impact Model are described below.

The Market-Share Matrix:

The *Fixed Market-Share* assumes that any industry j has a fixed share of the market for commodity i. It can be formulated in terms of the input-output matrix elements as: the ratio of each element of the make matrix, v_{ij}, representing the value of commodity i produced by industry j, to a total value of commodity i produced in the Ontario, q_i, is constant:

$$(12)\quad d_{ji} = v_{ji} \div q_i = \text{constant}$$

Using accounting identity (4), the gross output of any industry can be calculated from the commodity outputs, q_i, as:

$$(13)\quad g_j = \Sigma_i d_{ji} \cdot q_i \qquad j = 1, 2, ..., m;$$

or in matrix form:

$$(14)\quad \mathbf{g'} = \mathbf{D} \cdot \mathbf{q'}$$

where bold notation indicates a matrix or vector values the ' indicates transposition of the vector. Thus notation **q** represents row vector and **q'** is a column vector.

The matrix **D**, market-share matrix, is one of the matrices of structural coefficients of Ontario economy.

Thus, the fixed-market-share assumption implies that the production of the jth (multiproduct) industry is a weighted sum of the commodity outputs which it produces, where the weights are the coefficients d_{ij}. These weights sum to one across industries.

Since $g_j = \sum_j v_{ij} = \sum_i d_{ji} \cdot q_i$ $\quad j = 1, 2, ..., m$ implies

(15) $\sum_j d_{ij} = 1$ $\quad$ for $i = 1, 2, ..., n$

The Industry-Technology Matrix:

The *Fixed Proportion Production Function* assumption introduces a production function of the fixed proportion type, known as a Leontief production function:

(16) $g_i = \min(u_{ij} + b_{ij})$ $\quad$ for $i = 1, 2, ..., n$; and $j = 1, 2, ..., m$

The use of Leontief production function means that the quantity of each commodity used in the production process of industry j is a fixed proportion of this industry's gross output.

The matrix **B**, the Industry-Technology Matrix, gives the value of commodity i needed to produce a unit of gross output in industry j. This matrix of coefficients can be defined as the ratio of each use matrix element u_{ij} to the industry j gross output g_j:

(17) $b_{ij} = u_{ij} + g_j$ $\quad i = 1, 2, ..., n$; $j = 1, 2, ..., m$

where b_{ij} is the least amount of commodity i needed to produce one unit of output of industry j. The total amount of each commodity used in production can be then calculated from the industry gross outputs as:

(18) $u_i = \sum_j b_{ij} \cdot q_j$

or in matrix form,

(19) $\mathbf{U \cdot 1' = B \cdot g'}$

where **1'** is a unit column-vector.

If we let $F_{0i} = \sum_s F_{0is}$ represent the total final-demand use of each commodity manufactured in Ontario and arrange these in a final-demand vector, $\mathbf{F_0}$, the commodity-balance identities (3) can be represented in matrix form:

(20) $\mathbf{q' = B \cdot g' + F_0'}$

The commodity-balance model (20) together with the market-share model (14) form the core of the input-output model. These allow the commodity outputs and industry gross outputs to be calculated from a given vector of final demand. Substituting (14) into (20) we have:

(21) $\mathbf{q}' = \mathbf{B}\cdot\mathbf{D}\cdot\mathbf{q}' + \mathbf{F_0}'$

This matrix equation can then be solved for the commodity output vector **q**:

(22) $\mathbf{q}' = [\mathbf{I} - (\mathbf{B}\cdot\mathbf{D})]^{-1}\mathbf{F_0}'$ where **I** is an identity matrix.

The analogy between (22) and the familiar Leontief system $\mathbf{q}' = \mathbf{A}\cdot\mathbf{q}' + \mathbf{f}'$ is immediately apparent. The matrix **A** would be equivalent to the matrix **B** if the **D** matrix was an identity matrix, implying that every industry produced only one commodity. In this respect the "square" Leontief framework is inadequate as changes in the matrix **A** may correspond either to a technological change in input proportions or to a shift in market shares. The "rectangular" framework separates these effects.

By premultiplying (22) by the market-share matrix, **D**, we can solve for industry outputs.

(23) $\mathbf{g}' = \mathbf{D}\cdot\mathbf{q}' = \mathbf{D}[\mathbf{I} - \mathbf{B}\cdot\mathbf{D}]^{-1}\mathbf{F_0}'$

An equivalent mathematical expression to (23) may be obtained directly by first premultiplying the commodity-balance model (20) by the market-share matrix **D**:

(24) $\mathbf{g}' = \mathbf{D}\cdot\mathbf{q}' = \mathbf{D}\cdot\mathbf{B}\cdot\mathbf{g}' + \mathbf{D}\cdot\mathbf{F_0}'$

and subsequently solving (23) for the industry gross output vector.

(25) $\mathbf{g}' = [\mathbf{I} - \mathbf{D}\cdot\mathbf{B}]^{-1}\mathbf{D}\cdot\mathbf{F_0}'$

The production structure of the economy is modeled by (15) and (16) and the response of this structure to a change in final demand, for example consumption, can be calculated. However, more structural assumptions are necessary in order to completely model the economy. Parameters defining technology, the level of profit characteristic of the specific industry, the level of use of noncompetitive imports and the level of indirect taxes net of subsidies are assumed to be a fixed proportion of the industry gross output.

These assumptions link the primary inputs with the gross outputs of each industry. Five basic components define the elements of the primary-input matrices **Y** and $\mathbf{Y^f}$.

The Output-Income Relationship:

Primary Input-Output Assumptions relate the incomes received in the economy to gross domestic production.

In order to calculate the income associated with a given final-demand vector, further assumptions must be made concerning the primary-input matrices. Five basic components define the elements of the matrices **Y** and $\mathbf{Y^f}$. First, we have labour income, which includes the wage payments and benefits in each industry j, W_j, and in each category of final-demand s, W_s. Labour income is assumed to be a constant proportion of industry gross output.

$$(26)\quad W_j = w_j g_j$$

Second, we have net unincorporated business income in each industry j, E_j, and each final-demand category s, E_s. Net unincorporated business income in each industry is also assumed to be a constant proportion of industry gross output.

$$(27)\quad E_j = e_j g_j$$

Third, we have other operating surplus for each industry j, OOS_j, and each final-demand category s, OOS_s. Again, this element is assumed to be a constant proportion of gross output in each industry.

$$(28)\quad OOS_j = oos_j g_j$$

Fourth, we have indirect taxes less subsidies in each industry j, T_j, and final-demand categories, T_s. This element is also assumed to be a constant proportion of gross output in each industry.

$$(29)\quad T_j = t_j g_j$$

Fifth, we have non-competitive imports in each industry, MNC_j, and final-demand category, MNC_s. As above, this element is assumed to be a constant proportion of gross output in each industry.

(30) $MNC_j = mnc_j g_j$

These assumptions allow the calculation of primary inputs associated with a given final-demand vector. Once the vector of industry outputs, g, has been calculated it can be used to calculate the corresponding primary inputs. Thus labour income in industry, W, can be calculated from:

(31) $W = \mathbf{w} \cdot \mathbf{g}' = \sum_j w_j g_j$

where **w** denotes a row vector of labour income coefficients, w_j.

The total labour income in the economy, W_T, is then given by:

(32) $W_T = W + W_F$

where $W_F = \sum_s W_s$ is the total labour income associated with final s demand. In a similar manner we can calculate total net unincorporated business income, UIC, and total other operating surplus, OOS:

(33) $UIC = \mathbf{e} \cdot \mathbf{g}' + UIC_F = \sum_j e_j g_j + UIC_F$

where $UIC_F = \sum_s UIC_s$ is the total net unincorporated business income associated with final demand.

(34) $OOS = \mathbf{oos} \cdot \mathbf{g}' + OOS_F = \sum_j oos_j g_j + OOS_F$

where $OOS_F = OOS_s$ is the total other operating surplus associated with final demand.

The calculation of total taxes, T, is more complicated since it equals the sum of indirect taxes less subsidies on industry output and final demand, import duties on competitive imports, and direct taxes on wages, unincorporated business income and profits.

(35) $T = \mathbf{t} \cdot \mathbf{g}' + T_F + \mathbf{tm} \cdot \mathbf{mc}' + tax_1(W_T + UIC_T) + \mathbf{dt} \cdot \mathbf{g}'$ where:

- **t** is a row vector of indirect tax coefficients, t_j;
- $T_F = \sum_s T_s$ is the total indirect tax less subsidies associated with final demand;

- **tm** is a row vector of import tax coefficients, tm_i;
- **mc'** is a column vector of competitive domestic imports of each commodity, MC_i;
- tax_1 is the average income tax rate; and
- **dt** is a row vector of average corporate profit tax rates for each industry, dt_j.

There are two types of imports in the model, competitive and non-competitive. Competitive imports, which make up the major portion, are imports for which there exist domestically produced counterparts. Non-competitive imports have no corresponding domestic production. They include items such as coffee beans and tropical fruits. Competitive imports are assumed to be a constant fraction of total-industry and final-demand use (exclusive of imports) for each commodity.

(36) $MC_i = m_i[\sum_j b_{ij}g_j + F_{0i}]$

where m_i is the fraction of total domestic use of commodity i supplied by imports and F_{0i} is the final-demand use of commodity i exclusive of imports. In matrix form (36) becomes:

(37) $\mathbf{mc'} = \mathbf{m}[\mathbf{B}\cdot\mathbf{g'} + \mathbf{F_0'}]$

where **m** is a diagonal matrix of m_i values. Non-competitive imports by industries are related to industry outputs and are added to non-competitive imports in final demand to calculate total non-competitive imports, MNC.

(38) $MNC = \mathbf{mnc}\cdot\mathbf{g'} + MNC_F$

where $\mathbf{mnc} = \mathbf{mnc_j}$ represents the fractions of non-competitive imports per unit of gross output in each industry j and $MNC_F = \sum_s MNC_s$.

Total imports are the sum of competitive and non-competitive imports.

(39) $M = \mathbf{1}\cdot\mathbf{mc'} + MNC$

Domestic Output and Imports

The assumption that competitive imports are proportional to domestic commodity use as in (36) and (37) requires modification of the commodity balance model (20). Equation (20) states that:

$$\mathbf{q}' = \mathbf{B}\cdot\mathbf{g}' + \mathbf{f}'$$

where the final-demand vector, **f**, includes negative entries for competitive imports. If we redefine final demand to exclude competitive imports and denote this new value F_{0j}, then:

(40) $\mathbf{f}' = \mathbf{F_0}' - \mathbf{mc}'$

and the commodity balance model can be rewritten as

(41) $\mathbf{q}' = \mathbf{B}\cdot\mathbf{g}' + \mathbf{F_0}' - \mathbf{mc}'$

Substituting the competitive import equation (37) eliminates competitive imports from the commodity balance model.

(42) $\mathbf{q}' = \mathbf{B}\cdot\mathbf{g}' + \mathbf{F_0}' - \mathbf{m}[\mathbf{B}\cdot\mathbf{g}' + \mathbf{F_0}']$

or $\mathbf{q}' = [\mathbf{I} - \mathbf{m}][\mathbf{B}\cdot\mathbf{g}' + \mathbf{F_0}']$

Now use of the commodity-industry model allows calculation of commodity outputs and industry gross outputs from final demand excluding competitive imports. Using the commodity-industry model

(43) $\mathbf{q}' = [\mathbf{I} - \mathbf{m}][\mathbf{B}\cdot\mathbf{D}\cdot\mathbf{q}' + \mathbf{F_0}']$ which implies

(44) $\mathbf{q}' = [\mathbf{I} - [\mathbf{I} - \mathbf{m}]\mathbf{B}\cdot\mathbf{D}]^{-1}[\mathbf{I} - \mathbf{m}]\mathbf{F_0}'$ and

(45) $\mathbf{g}' = \mathbf{D}[\mathbf{I} - [\mathbf{I} - \mathbf{m}]\mathbf{B}\cdot\mathbf{D}]^{-1}[\mathbf{I} - \mathbf{m}]\mathbf{F_0}'$

Alternatively, the vector of industry gross outputs can be calculated by premultiplying the commodity-balance model by the make matrix.

(46) $\mathbf{g' = D \cdot q' = D[I - m\,][B \cdot g' + F_0']}$ which implies

(47) $\mathbf{g' = [I - D(I - m)B]^{-1}D(I - m)F_0'}$

Closing the Model:

The equation systems in (44) and (45) solve only for initial and indirect domestic commodity and industry output. Final-demand components are treated as exogenous to the system. This treatment is not adequate because consumption can be expected to be linked to the level of labour income. Thus a final-demand vector which implies a larger labour income should also imply more consumption. When the consumption is related to income, the solution of the system includes not only direct and indirect effects, but also income *induced* effects. Thus the model is completed by adding a relationship linking consumption, C, to income, N:

(48) $C = b \cdot N,$

where b is the average propensity to consume.

Income is defined as the sum of labour income, W, and net income of unincorporated business, UIC. Thus, income is related to gross industry outputs by the vectors of primary-input coefficients **w** and **e**.

(49) $N = \sum_j (w_j + e_j)g_j + (w_c + e_c)C + W_F$

$= [\mathbf{w} + \mathbf{e}]\mathbf{g'} + (w_c + e_c)C + W_F$

where W_F is the sum of labour income associated with all final-demand components except consumption and competitive imports.

The integration of consumption into the model is completed by assuming that the values of commodities and primary inputs that enter into consumption expenditure are fixed proportions of the total value of consumption:

(50) $C_i = c_i \cdot C$ $\quad i = 1, 2, ..., n;$ or, in matrix form,

$\mathbf{f_c' = c' \cdot C}$

where c_i is the proportion of consumption used to purchase commodity i and $\mathbf{c}'$ is the column vector of c_i's, and by assuming:

$$(51)\quad W_c = (w_s + e_s)C$$

where w_s is the proportion of the total value of consumption spent on labour and e_c is the proportion of the total value of consumption which generates net income of unincorporated business.

The income concept defined in (49) does not include dividends, government and private transfers or income taxes and other direct taxes and may, therefore, not accurately represent personal disposable income. On the other hand, the inclusion of dividends, government transfers and direct taxes would require information on the distribution of dividends and other private transfers between Ontario, the other provinces and abroad. This information is not available.

The inclusion of consumption within the system modifies its structure, which now assumes the following configuration:

$$(52)\quad \begin{bmatrix} \mathbf{I - D(I - m)B} & \mathbf{- D(I - m)c' \cdot b} \\ \mathbf{-(w + c)} & \mathbf{1 - (w_c + e_c)b} \end{bmatrix} \begin{bmatrix} \mathbf{g'} \\ \mathbf{N} \end{bmatrix} = \begin{bmatrix} \mathbf{D(I - m)f'} \\ \mathbf{W_F} \end{bmatrix}$$

Calculation of Impacts:

The province-wide impacts of MTO Programs are computed by replacing the vector f in the equation system (52) by the vector of commodity demands associated with a particular project or program expenditure, P, where P_{ir} is the demand for commodity i associated with program r, and W_F by W_r, the direct labour income associated with program r. The resulting values of q, g and N represent the changes associated with the project or program.

Note that (52) assumes that a constant fraction of each construction input, P_{ir}, is supplied by competitive imports. For the projects considered in this report, however, it is more reasonable to assume that these commodity inputs are supplied by the Ontario economy. Thus, the terms [I - M]**f** are replaced by **P** in calculating the impacts of MTO projects.

This calculation assumes that: 1) the marginal impacts are governed by the fixed proportion and fixed-market-share assumptions in the model described above, and by the average numerical values which are used to specify the input-output model; and 2) there are sufficient primary resources available to supply the additional demands without leading to primary-input price changes.

A.3/ Conversion of 1979 Outputs to 1987 Outputs

As noted at the beginning of this chapter, the input-output table for Ontario that is currently available reflects 1979 prices. Thus, based on the system so far described, the model calculates the 1979 values of impacts of projects based on input values which have been deflated from 1987. These 1979 outputs must be readjusted to 1987 values in order to obtain an accurate measure of the impacts of projects undertaken in 1987. In the description that follows, 1987 values for outputs should be understood as values adjusted to account for average price changes from 1979 to the end of 1986.

The basic data required for this adjustment are a set of industry selling price indexes, $PG87_j$ and industry wage indexes, $WI87_j$, which have 1979 as their base year. In addition, price indexes for non-competitive imports, PNCM87, and consumption, PC87, are required.

Commodity price indexes can be calculated from the make matrix and the industry price indexes using the fixed-market-share assumption. This assumption implies that commodity price indexes are weighted averages of the selling prices of the supplying industries.

$$(53)\quad PQ87_i = \Sigma_j d_{ji} PG87_j \qquad i = 1, 2, ..., n$$

Industry gross outputs are adjusted using the industry price indexes:

$$(54)\quad g87_j = PG87_j g79_j \qquad j = 1, 2, ..., m$$

And commodity outputs are adjusted using the commodity price indexes:

$$(55)\quad q87_i = PQ87_i q79_i \qquad i = 1, 2, ..., n$$

The adjustment of labour income by industry is similarly straight forward, using the industry wage indexes:

$$(56)\quad N87_j = WI87_j N79_j \qquad j = 1, 2, ..., m$$

Labour income in consumption is adjusted in a similar manner using the wage index for the personal services industry. Noncompetitive imports in industry and in consumption are adjusted using a common price index for non-competitive imports, PMNC87:

(57) $MNC87_j = PMNC87 \cdot MNC79_j$ $\quad j = 1, 2, ..., m,$ and

(58) $MNC87_c = PMNC87 \cdot MNC79_c$

Indirect taxes by industry and in consumption are calculated assuming that the 1979 indirect tax rates also apply in 1987. (This assumption can be modified to account for known changes to the tax system.) These rates are applied to 1987 values:

(59) $T87_j = t_j g87_j$ and

(60) $T87_c = t_c C87$

where consumption in 1987 values has been calculated by applying the price index for consumption.

(61) $C87 = PC87 \cdot C79 = PC87 \cdot b \cdot N79$

The only remaining element to adjust to 1987 values is other operating surplus. Following the practice used in calculating constant price input-output tables, these elements are found residually for each industry and for consumption.

(62) $OOS87_j = g87_j - \Sigma_{i=1}^{43} PQ87_i b_{ij} g79_j - MNC87_j - T87_j - N87_j$ $\quad j = 1, 2, ..., m$ and

(63) $OOS87_c = C87 - \Sigma_{i=1}^{43} PQ87_i \, c_i b \cdot N79 - MNC87_c - T87_c - N87_c$

A.4/ Calculation of Energy Impacts

The energy impacts of a capital spending project are expressed as the total amounts of use of primary energy forms, expressed both in terms of physical quantities and energy units, associated with the direct, indirect and induced effects of the project. The primary energy sources reported are coal, crude oil, natural gas, hydro and nuclear generated electricity, and other primary energy (liquified petroleum gases and steam from nuclear electricity generation).

Conceptually, the above energy uses could be computed either from commodity outputs or industry gross outputs associated with the project. The availability of energy use data for Ontario, based on industry uses, makes the industry-based calculation the most convenient. Because the input-output data system contains the value of industry gross outputs for Ontario in 1979, these can be related to data on Ontario energy uses in 1979, in order to link energy uses to industry gross outputs in an energy-use model. The 1979 values of industry gross outputs, g_j, (and consumption, C) which are calculated using the input-output model, are then used as inputs into the energy-use model.

The energy use data for Ontario describes the use of both primary and secondary (coke, coke oven gas, refined petroleum products and thermal electricity) energy forms by industry, and the use of primary energy forms to produce secondary energy forms. Thus both direct uses of primary energy and indirect uses through secondary energy forms can be linked to industry gross outputs. We assume that for each industry (and the household sector) both primary, EP, and secondary, ES, energy uses are proportional to industry gross output (and the total level of household consumption).

(64) $EP_{uj} = ep_{uj}g_j$ $\quad u = 1, 2, ..., 5; j = 1, 2, ..., m$

(65) $EP_{uc} = ep_{uc}C$ $\quad u = 1, 2, ..., 5$

(66) $ES_{vj} = es_{vj}g_j$ $\quad v = 1, 2, ..., 4; j = 1, 2, ..., m$

(67) $ES_{vc} = es_{vc}g_j$ $\quad v = 1, 2, ..., 4$

The total uses of secondary energy are then obtained by summing over all users and "grossing-up" to account for producer use.

(68) $ES_v = a_v(\sum_j ES_{vj} + ES_{vc})$ $\quad v = 1, 2, ..., 4$

where a_v is the ratio of gross output to net output of secondary energy form v.

The uses of each primary energy form to produce each secondary energy form are also assumed to be proportional.

(69) $EP_{uv} = et_{uv}\, ES_v$ $\quad u = 1, 2, ..., 5; v = 1, 2, ..., 4$

Finally, the total use of each primary energy form can be calculated by summing across direct and indirect uses and grossing-up to account for producer use.

$$EP_u = a_u(\Sigma_j EP_{uj} + EP_{uc} + \Sigma_v EP_{uv})$$

$$= a_u(\Sigma_j ep_{uj} g_j) + ep_{uc} C + \Sigma_v et_{uv} a_v(\Sigma_j es_{vj} g_j) + es_{vc} C$$

$$= \Sigma_j(a_u ep_{uj} + \Sigma_v et_{uv} a_v es_{vj}) g_j + (a_u ep_{us} + (\Sigma_v et_{uv} a_v es_{vc}) C$$

where a_u is the ratio of gross output to net output of primary energy form u.

Since industry and household uses of electricity are not separated into thermally generated (secondary) and hydro and nuclear generated (primary) forms, it was assumed that the proportions of each form of electricity used were the same for each user.

$$ep_{4j} + ep_{5j} = ep_{4c} + ep_{5c} = (\Sigma_j EP_{4j} + EP_{4c}) + (\Sigma_j ES_{5j} + ES_{5c}) \qquad j = 1, 2, ..., m$$

We should also note that account was taken of non-energy uses of primary energy forms such as crude oil for asphalt and crude oil and natural gas for petrochemicals.

A.5/ Model Data Sources

The Ontario Input-Output data system for 1979 was obtained from the Input-Output section of Statistics Canada. This data set includes: the make matrix, **V**; the use matrix, including **U** and **Y**; and the final-demand matrix, including **F** and **Y·F**. These data were the basis for the calculation of all the parameters in the core input-output model represented by equation system (50). In addition, coefficients for indirect taxes, t_j and t_c, non-competitive imports, m_j and m_c, and consumption, b, were based on the input-output data. The data were available on a 43 commodity and 25 industry basis.

The adjustment of input data to 1979 values and output data to 1987 values requires price indexes for industry gross outputs, $PG87_j$, and wage indexes by industry, $W87_j$. These indexes, together with a price index for consumption, PC87, are also used to calculate impacts in 1987 values. The price indexes used for most industry gross outputs are industry selling price indexes taken from Industry Price Indexes, Statistics Canada (62-011), Table 1 (Table 2 in recent issues), Industry Selling Price Indexes. For industries not covered in this publication, other sources were used.

For agriculture, data for Ontario was taken from Index Numbers of Farm Prices for Agricultural Products, Statistics Canada (62-003). For forestry, the wood price index from Table 4, Raw Materials Price Index, in Industry Price Indexes was used. For mining, a weighted average of price indexes for ferrous metals, non-ferrous metals, non-metallic minerals, and coal, crude oil and natural gas, all from the same source (Raw Materials Price Index) was used. The weights were taken from the mining column of the Ontario market-share matrix. For fishing, the fresh fish price index from Industry Selling Prices, Table 1, was used to represent the industry selling price.

The *other manufacturing* industry is a composite of several industries which could not be obtained separately because of confidentiality restrictions, in addition to the miscellaneous manufacturing industry. Industries included are tobacco, rubber, plastics, and leather products; clothing; and miscellaneous manufacturing. Industry selling prices for these industries were averaged together, using weights from the Ontario make matrix, in order to construct a price index for other manufacturing.

For construction, output price indexes of non-residential construction for Toronto were obtained from Construction Price Statistics, Statistics Canada (62-007), Table 7.1. For utilities, electric power selling price indexes for Ontario were taken from Industry Selling Prices, Table 3. For the trade and finance, and business and personal services industries, the implicit price deflator for services was taken from the Canadian Statistical Review, Statistics Canada (11-003), Table 1.8.

The housing industry is a dummy industry whose only output is the inputted rent on owner-occupied housing. The price for this industry was taken to be the Toronto price index for owned accommodation, which includes mortgage interest and replacement costs, from The Consumer Price Index, Statistics Canada (62-001), Table 3. The price index for consumption was taken from the all-items index for Toronto from the same source. The price index for cocoa, coffee, tea and other food preparations from Industry Selling Prices, Table 4 (raw materials), is used as the price index for non-competitive imports.

Wage indexes for manufacturing industries were based on estimated annual earnings by industry in Ontario reported in Employment, Earnings and Hours, Statistics Canada (72-002). For other industries the following sources were used. For agriculture, the index was based on farm net income reported in Ontario Statistics. For fishing, the index was based on average weekly wages in the fish products industry, taken from Employment, Earnings and Hours. For the trade and finance industry, wages from the trade and the real estate, finance and insurance industries were averaged together using labour income shares.

Calculation of direct taxes require data on direct taxes by industry and direct taxes paid by households. The Provincial Economic Accounts, Statistics Canada (13-213), contain data on direct taxes paid by households and also by business in Ontario. The business data, however, is not broken down by industry. National tax data, from Corporation Taxation Statistics, Statistics Canada (61-208) give direct taxes broken down by industry but not by province. Initially, the industry totals from Corporation Taxation Statistics were allocated across provinces in proportion to other operating surplus by province (taken from the input-output data for each province), creating an industry by province array. This procedure assumes that direct tax rates are the same across provinces for each industry. The provincial totals from this initial allocation do not, however, agree with the provincial totals from the Provincial Income and Expenditure Accounts. The initial array was subsequently adjusted by an RAS procedure until it was consistent with both the published industry and provincial totals. These data were then used to calculate direct taxes as a proportion of other operating surplus for each industry in Ontario. The above calculations were carried out using 1979 data.

The data on energy use in Ontario in 1979 which was used to calculate the energy-use coefficients was taken from the Quarterly Report On Energy Supply-Demand in Canada, 1979-IV, pp. 80-81, Statistics Canada (57-003).

The industry selling price indexes described above are used to calculate commodity price indexes. These commodity price indexes are appropriate for the broad aggregates in the input-output model but may not be representative of the particular commodities or labour used in Ministry programs. Thus, for the purpose of deflating project inputs to 1979 values, it is preferable to use a different set of commodity input price indexes. There are published sources for most highway construction inputs on a national basis, but only labour (in Construction Price Statistics), fuel, asphalt and redi-mix concrete (in Industry Price Indexes) are available for Ontario. To remedy this, input price data for Ontario were provided by the Ministry's Estimating Office. Where the above sources did not provide adequate information, national indexes for construction inputs (from Industry Price Indexes) were used. The sources for these indexes are shown in the following table.

Table A2/ Sources for Construction Input Price Indexes

Commodity Name	Source
Agricultural & Forestry Products	Price Index for Logs & Bolts, Table 7; Industry Prices Indexes (IPI), Statistics Canada (62-011)
Non-Metallic Minerals	Price Index for Crushed Stone, Table 4, IPI
Rubber & Plastic Products	Price Index for Rubber Products, Table 3, IPI
Wood Products	Price Index for Lumber & Timber, Table 2, IPI
Primary Metal Products	Price Index for Primary Metal Products, Table 3, IPI
Metal Fabricated Products	Price Index for Metal Fabricated Products, Table 3, IPI
Machinery & Equipment	Price Index for Construction Machinery & Equipment, Table 2, IPI
Transportation Equipment	Price Index for Trucks, Domestic, Heavy, Table 2, IPI
Electrical Products	Price Index for Electric Wire & Cable, Table 2, IPI
Non-Metallic Mineral Products	Average of Price Indexes for Concrete Products and Redi-Mix Concrete, Ontario, Table 2, IPI
Petroleum and Coal Products	
a) Fuel	Price Index for Diesel Fuel, Ontario, Table 2, IPI
b) Asphalt	Price Index for Asphalt, Ontario, Table 2, IPI
Chemicals	Prices for calcium chloride, from Unit Price Files, MTO
Transportation & Storage	Index for Construction Equipment Rental (see below)
Insurance	Index for Services
Business Services	Index for Services
Personal & Other Services	
a) Construction Equipment Rental	Average of Price Indexes for Front End Loader, Grader, from Unit Price Files, MTO
b) Repairs	Index for services
Operating, Office, Lab & Food	Index for services
Travel, Advertising & Promotion	Index for services
Labour Income	Average index for 16 construction trades, Hamilton from Table 2.2, Construction price statistics, Statistics Canada (62-007)

Appendix B/ The Relationship Between TRIM and MIES

The Micro-Economic Impact Evaluation System (MIES) is an earlier input-output based model that was designed to evaluate the impacts of the Provincial Highways spending program. The most recent version, MIES 3, was completed in 1982. Although MIES and TRIM both attempt to assess the economic impact of capital projects, a number of differences distinguish the two systems. These differences may be grouped into four categories: differences in data describing Ministry projects; differences in input-output data; differences in the structures of the two models; and differences in the outputs prepared by the two systems. An account of these differences is given below.

B.1/ Differences in Project Input Data

MIES 3 contained input data on 10 provincial highway projects. TRIM uses these same ten projects (SUP group C), but updates the input data to 1986/87 prices, thus taking account of the substantial changes in the relative prices of highway construction inputs which have occurred since 1982. In addition, the TRIM inputs are expressed in terms of a physical project scale, such as 100 metres of roadway, while the MIES 3 inputs were scaled to units of $1 million worth of expenditures.

TRIM also includes input data on 25 additional projects (SUP groups A, B and D) drawn from other Ministry program areas, thus substantially broadening the project input data base.

In addition, (in expert mode) TRIM allows users to enter their own menus of expenditures or to modify, either by scaling or by changing individual items, the SUP menus. With scaling and addition of the SUPs by the TRIM user, various combined expenditure programs can also be created. This flexibility in the creation of input data makes TRIM a versatile tool for the expert user.

B.2/ Differences in Input-Output Data

MIES 3 was based on the 1974 Canadian Interprovincial Input-Output Tables constructed by Statistics Canada. TRIM is based on the 1979 Ontario Input-Output Tables (also constructed by Statistics Canada).

MIES 3 used average provincial tax rates for both personal and corporate business income in order to calculate tax impacts. TRIM also uses average provincial tax rates for personal income, but uses industry specific average tax rates for corporate business income.

MIES 3 calculates employment impacts by dividing labour income generated by the input-output model by average wage rates. TRIM uses employment coefficients based on Labour Force Survey data on employment by industry in Ontario in order to calculate employment impacts.

B.3/ Differences in the Models

Both MIES 3 and TRIM are *closed* input-output models which take account of consumer demand induced by income increases (the induced effects first referred to in Chapter 2) and of import leakages out of the Ontario economy. MIES 3 is based on the full interprovincial input-output system and, thus, takes account of feedbacks from other provinces. For example, if a capital spending project leads to demand for products from Alberta, the production and income generated in Alberta may lead to further demand for products from Ontario. At an early stage of this project, it was decided not to incorporate these feedbacks into the TRIM model.

MIES 3 takes inputs valued at current year prices (1982, for example) and multiplies these inputs by the coefficients implied by the 1974 input-output tables. The outputs are then interpreted as if they were valued at current year (1982) prices. This procedure implicitly assumes that both the input-output structure of Ontario and the relative prices of all commodities and industries have not changed since 1974 (or that changes have been exactly offsetting). TRIM adjusts input values from the current year (the beginning of 1987, for example) to 1979 values using price indexes, calculates impacts in 1979 prices, and then adjusts these impacts to current year (1987) values. This procedure accounts for changes in relative prices, but still assumes a constant input-output structure.

B.4/ Differences in Model Output

MIES 3 and TRIM both provide private sector employment impacts for Ontario, broken down into initial, indirect and induced impacts. MIES 3 also presents employment impacts associated with the Ministry's project supervision of the ten Provincial Highway projects. These impacts are not reported in TRIM. Because it is based on the interprovincial input-output system, MIES 3 also calculates employment impacts in other provinces. These impacts are not calculated by TRIM.

TRIM also reports Gross Domestic Product, gross sales and labour income; broken down into initial, indirect and induced impacts.

Tax impacts are provided by both MIES 3 and TRIM. MIES 3 reports Ontario tax revenues, broken down into business and personal income taxes, and sales taxes. TRIM reports taxes collected at the federal, provincial (Ontario) and local levels; these are broken down into personal income tax, indirect business tax, tariffs, corporate profits tax, and local property and business taxes.

MIES 3 and TRIM both report imports from outside Canada. TRIM calculates these foreign imports for Ontario only, while MIES 3 calculates them for Ontario and for other provinces. TRIM also reports Ontario's imports from other provinces.

TRIM calculates and reports uses of primary energy sources, in both physical and energy units, associated with each capital expenditure project. MIES 3 does not calculate these impacts.

Each TRIM output which is measured in dollars (Gross Domestic Product, gross sales, labour income, taxes and imports) is expressed in terms of 1987 prices. If MIES 3 inputs are based on 1987 prices the resulting outputs can also be interpreted as being in 1987 prices.

Appendix C/ TRIM: Standard Unit Projects – Quick Reference Guide

(See Chapter 3 for full descriptions.)

Municipal Road Projects

Collector/Arterial Roads:

SUP A1. Six-Lane

SUP A2. Five-Lane

SUP A3. Four-Lane

SUP A4. Two-Lane

- reconstruction of deteriorated roadway
- roadway length: 100 m
- lane width: 3.5 m
- concrete curb & gutter
- 1.5 m boulevard
- 1.5 m sidewalk

SUP A5. Two-Lane Rural Road

- reconstruction
- length: 100 m
- lane width:3 m
- 1 m shoulders
- minor widening
- full ditching

SUP A6. Two-Lane Local Road

- reconstruction
- length: 100 m
- road width: 8.5 m
- standard curb and gutter
- lawn & driveway restoration
- no widening or sidewalk replacement

Municipal Bridges:

SUP A7. Three-Span Rehabilitation

- spans: 7.6 m, 18.3 m, 7.6 m
- reinforced concrete T-beams
- roadway width: 9.14 m
- no sidewalks

SUP A8. Short-Span Construction (Over Land)

SUP A9. Short-Span Construction (Over Water)

- span: 17.5 m
- roadway width: 8 m (two lanes)
- 1.5 m sidewalk (one side only)
- water footings on limestone bedrock
- OHBDC '83, Class C loading

SUP A10. Medium-Span Construction (Over Land)

SUP A11. Medium-Span Construction (Over Water)

- 3 spans: 27 m, 30 m, 27 m
- roadway width: 9.5 m (two lanes)
- no sidewalk
- precast girders
- reinforced concrete deck
- water footings short piles on bedrock
- OHBDC '83, Class C loading

Airport Projects

SUP B1. Major Runway Upgrade, 2 000 ft

SUP B2. Major Runway Upgrade, 3 500 ft

SUP B3. Major Runway Upgrade, 5 000 ft

- rebuild runways & taxiways
- runway width: 30 m
- drainage
- fencing & landscaping
- lighting
- navigational aids
- meteorological equipment
- refurbish terminal

- fuel tanks
- connections to external power

SUP B4. Navaid Upgrade, 2 000 ft
SUP B5. Navaid Upgrade, 3 500 ft
SUP B6. Navaid Upgrade, 5 000 ft

- new wiring
- lighting
- visual & instrument landing systems
- meteorological equipment
- connections to external power

SUP B7. Minor Runway Upgrade, 2 000 ft
SUP B8. Minor Runway Upgrade, 3 500 ft
SUP B9. Minor Runway Upgrade, 5 000 ft

- widening
- resurfacing
- new subdrains
- seeding & mulching of periphery

SUP B10. Airport Access Road, 200 m
SUP B11. Airport Access Road, 500 m

- identical to SUP A5, except in length

Provincial Highway Projects

Data for SUPs C1-C10 were developed in the Ministry for the Micro-Economic Impact Evaluation System. For a description of their adaptation to the structure of TRIM see pp. 26-29.

SUP C1. New Construction – Unpaved, Two Lanes
SUP C2. New construction – Paved, Four Lanes
SUP C3. Reconstruction – Paved, Two lanes
SUP C4. Reconstruction – Paved (with rock), Two Lanes
SUP C5. Resurfacing, Two Lanes
SUP C6. Resurfacing, Recycled Hot Mix (less than four inches), Two Lanes
SUP C7. Post-Tensioned Concrete Structure (cast in place)
SUP C8. Bridge Deck – Latex-Modified Concrete Overlay
SUP C9. Bridge Deck Repairs – Latex Patching, Asphalt Overlay

SUP C10. Major Widening (no structures)

- SUPs C1-C6 and C10 refer to 1 km of highway
- SUPs C7-C9 refer to 1 m^2

Provincial Transit Projects

SUP D1. Suburban Parking Lot Construction, 200 spaces

- 75 mm asphalt coating
- full drainage
- curbing
- full illumination

SUP D2. Suburban Parking Lot Construction, 100 spaces

- 50 mm asphalt coating
- no curbs
- drainage limited to ditching
- minimal illumination

Municipal Transit Project

SUP E1. Municipal Transportation Centre

- administration building, 2 floors 2 540 m^2 each, basement 630 m^2
- bus storage area, 150 buses
- maintenance area, 10 550 m^2
- lunch rooms & clerical offices